Sea Cucumber Biomass Estimations From Surveys Conducted June 2009 to May 2010

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ABSTRACT

Duprey, N.M.T. 2011. Sea cucumber biomass estimations from surveys conducted June 2009 to May 2010. Can. Manuscr. Rep. Fish. Aquat. Sci. 2954: viii + 97p.

Stock Assessment surveys of the sea cucumber, *Parastichopus californicus*, population in British Columbia have been ongoing since 1998. Between June 2009 and May 2010, six surveys were conducted to provide managers with population density and biomass estimates, as well as recommendations for no-take reserves and commercial harvesting. The relative abundance of red sea urchin (*Strongylocentrotus franciscanus*), green sea urchin (*S. droebachiensis*), and geoduck (*Panopea generosa*) were also measured and are presented here. Area 3 South, Area 3/4 Mainland (with poor sea cucumber habitat removed), Area 7 Mathieson, and Area 7–24 had high sea cucumber densities, with most Subareas' 90% lower confidence bounds exceeding their Region's baseline density. Area 17 densities were low and most areas were not recommended to be opened for commercial harvesting.

RÉSUMÉ

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Des relevés des stocks de la population des concombres de mer du Pacifique (*Parastichopus californicus*) en Colombie-Britannique sont réalisés depuis 1998. De juin 2009 à mai 2010, six relevés ont fourni des estimés de densités et de biomasses aux gestionnaires ainsi que des recommandations quant aux réserves sans captures et à la récolte commerciale. Des abondances qualitatives d'oursin rouge (*Strongylocentrotus franciscanus*), d'oursin vert (*S. droebachiensis*) et de la panope du Pacifique (*Panopea generosa*), sont présentées dans ce document. Le secteur 3 sud, les secteurs 3 et 4 côte continentale (où les zones d'habitat pauvres en concombres de mer n'ont pas été considérées), le secteur 7 Mathieson, de même que le secteur 7-24, présentaient de hautes densités en concombres de mer, la plupart des sous-secteurs ayant leurs limites inférieures de 90% de l'intervalle de confiance au-dessus des densités de base calculées dans ces régions. Les densités dans le secteur 17 étaient faibles, et plusieurs des sous-secteurs n'ont pas été recommandé pour l'ouverture de la pêche commerciale.

INTRODUCTION

The commercial giant red sea cucumber, *Parastichopus californicus*, fishery in British Columbia has an annual value of approximately 2.8 million Canadian dollars (P. Ridings, Fisheries and Oceans Canada, 417- 2nd Ave West, Prince Rupert, British Columbia, V8J 1G8, pers. comm.). Landings were first recorded in Canada in 1971, and the fishery underwent several management changes through the 1980's and 1990's. Since 1995, the fishery has undergone a rigorous period of data collection, analysis and information review. The objective was to develop a biologically-based stock assessment program and risk-averse fishery management. The first sea cucumber stock assessment and quota options paper was completed in 1995, utilizing a surplus production model (Phillips and Boutillier 1998). In the course of conducting this assessment, gaps in knowledge of the species' biology were identified and shortcomings of the fishery-dependent data became clear. Phillips and Boutillier (1998) identified the need for a change in approach for the BC sea cucumber fishery and laid the groundwork for a more comprehensive, Phase 0 (Perry et al. 1999), review in 1996 (Boutillier et al. 1998). The Phase 0 review paper concluded that the fishery was not providing the information necessary for stock assessments and evaluation of the impacts of the commercial fishery on sea cucumber populations. Accordingly, it was recommended that the fishery henceforth be conducted in a manner that would provide the necessary data. Thus, in 1997, Phase 1 of the sea cucumber fishery began (Hand and Rogers 1999), wherein the area open to commercial harvest was restricted to a static 25% of the coast, 50% of the coast was closed to harvest, and the remaining 25% of the coast was set aside for experimental fishery research. Since only a small fraction of the area allocated for research was used, the closed area encompassed almost 75% of the coast. A fishery-independent survey program was initiated in areas open to commercial harvest (termed 'Open' surveys) in BC. These Open surveys are used to determine the density and biomass of sea cucumbers in a given area.

After 10-years of fisheries-dependent and -independent research conducted in the Phase 1 regime, the data collected from Open surveys, experimental fisheries and biological sampling were analyzed and the results and recommendations were presented to and accepted by the Pacific Invertebrate Subcommittee of the Canadian Science Advisory Secretariat (CSAS) in 2007 (Hand et al. 2008). The recommendation to allow re-opening of the commercial fishery beyond the geographically-restricted 25% of the shoreline, using BC-based exploitation rates, was endorsed. It was also recommended and approved that any re-opened areas should be surveyed prior to commercial harvesting taking place (Hand et al. 2008; Duprey et al. 2011). The sea cucumber fishery then entered Phase 2, 'fishing for commerce' (Perry et al. 1999).

Prior to re-opening areas in BC to commercial harvesting, surveys are conducted to estimate the density and biomass of sea cucumbers within them. A total of 55 PFMA Subareas were surveyed from July 2007 to May 2009, and survey results have provided site-specific estimates of sea cucumber density and biomass. The Integrated Fishery Management Plan (DFO 2009) lists all PFMA Subareas currently open for commercial harvest of sea cucumbers.

This manuscript report presents the results of five Open surveys conducted between June 2009 and May 2010: two Open surveys in the North Coast (Area 3 South and Area 3/4 Mainland); two surveys in the Central Coast (Area 7 Mathieson and Area 7–24); and one Open survey in the South Coast (Area 17). This report also presents results for one permanent BioTransect survey in the Central Coast (Area 7–14).

Three of the Open surveys (Area 3 South, Area 3/4 Mainland, and Area 17) were not open at the time of surveying, but were being considered for opening in the upcoming 2010–11 harvest season. One Open survey (Area 7 Mathieson) had been re-opened for the 2009–10 harvest season, but had not been surveyed prior to opening. The two remaining surveys were part of the original 25% of the coastline that remained open in 1998, but had never been surveyed (an Open survey in Area 7–24 and a permanent BioTransect survey in Area 7–14).

This report summarizes the survey protocols, describes the survey methodology and presents the results of data analysis for density, mean weight and biomass of the *Parastichopus californicus* populations, density estimates for the sea cucumbers *Cucumaria miniata* and *C. pallida* populations and relative abundance estimates of geoducks (*Panopea generosa*), red sea urchins (*Strongylocentrotus franciscanus*) and green sea urchins (*S. droebachiensis*).

METHODS

Open surveys are the standard survey method used in British Columbia to assess the *Parastichopus californicus* population (Duprey et al. 2011). They are used to assess density and biomass in areas currently open to commercial harvesting or areas that are currently closed but there is a desire to re-open the area in upcoming years. Permanent BioTransect surveys are conducted in areas open to commercial harvesting. They provide the estimates of mean weight used in biomass calculations; and can be calculated every couple of years with minimal effort. They do not provide any density estimates.

OPEN SURVEY METHODS

Surveying

While each Open Survey was prepared separately, the methods used to prepare and conduct each survey are the same. Firstly, the entire shoreline of the each PFMA Subarea was measured using ArcGIS 9.3 (Table 1). The basemap used to measure the shoreline was the cucland.shp dataset, projected in BC Albers. One transect was allocated for every 2 kilometers of shoreline located in the PFMA Subarea. Using the ArcGIS 9.3 measurements, transect locations were determined by placing transects systematically every two kilometers along the shoreline using Xtools (see Table 1 for total number of surveyed transects by PFMA Subarea).

Each transects was surveyed by two SCUBA divers. A marked leadline was placed in a perpendicular line to shore, from zero gauge depth to 15.2 m gauge depth. A buoy was anchored to the deep end of the line and the two divers descended the buoy line and began the survey at approximately 15.2 m (50 ft) gauge depth. Each diver had a 2 m pole with an attached datasheet. One diver was designated as the left diver and one the right; each diver was responsible for counting the number of sea cucumbers on their side of the transect line. The left diver was responsible for counting the sea cucumbers straddling the transect line. The leadline itself was marked with zapstraps and coloured electrical tape at 5 m intervals. The divers recorded the number of sea cucumbers in each 5 m interval, called a quadrat, along the line. The number of adult and juvenile (sea cucumbers smaller than a pencil) *Parastichopus californicus*, up to three dominant substrate types and up to two dominant algae types were recorded for each quadrat. A sea cucumber was considered inside the quadrat if more than half the animal was within the quadrat. The depth of each quadrat was also recorded. One diver also recorded the number of *Cucumaria miniata* and *C. pallida* on their side of the transect (not done in the Area 17 survey). As only one diver was recording this information, the swath covered was only 2 m wide compared to the 4 m wide swath covered for *P. californicus*. Abundance estimates of red sea urchins (*Strongylocentrotus franciscanus*), green sea urchins (*S. droebachiensis*), and geoducks (*Panopea generosa*) were also recorded on the dive regardless of how far they were seen from the transect line; each transect was designated as having either None, Few (1–10), Many (11–100) or Abundant (100+) animals.

Biosampling

The average weight and weight-frequency distribution of the populations was determined from biosamples, small collections of *P. californicus* that were individually weighed. Biosamples were collected from predetermined transects that were randomly selected from all transect locations. Approximately one biosample is collected for every 10 transects in an Analysis Area. After these selected transects were surveyed, the divers handpicked 25 sea cucumbers from the 4 meter wide transect line and the surrounding area. Divers do not collect animals deeper than 15.2 m gauge depth. The animals were then brought on board the boat, where they were longitudinally split, left to drain and, at the end of the day, individual weighed. A total of 60 biosamples were collected from the five Open surveys presented in this report (the sampling protocol for permanent BioTransects collected in Area 7–14 are described in the next section).

PERMANENT BIOTRANSECTS

Permanent BioTransects were established to provide mean sea cucumber weight data from static areas and with minimal effort, immediately before the fishery opens. Permanent transects were constructed by placing a cement block at the shallow and deep (15.2 m) ends at the chosen location and running ground line between the two blocks. Permanent BioTransects are set up in un-surveyed PFMA Subareas to provide data on sea cucumber mean weight for biomass calculations (Duprey et al. 2011). BioTransects were surveyed by two divers, who collect every sea cucumber encountered within 2 meters of the line. The animals were then brought on board the boat, where they were longitudinally split, left to drain and when the survey was complete they were transported to a local biologist for individual weighing.

SURVEY AREA DESCRIPTIONS

The five Open surveys conducted between July 2009 and June 2010 stretched from the Alaskan border to the northern Gulf Islands on the east coast of Vancouver Island. One permanent BioTransect survey was established in Area 7–14.

Area 3 South

Area 3 South is located entirely within Pacific Fisheries Management Area (PFMA) 3, located in the North Coast region (Figure 1). This area had been closed to sea cucumber harvesting since 1998 and was surveyed for potential re-opening, and included six previously unsurveyed PFMA Subareas (3–3, and 3–6 to 3–10). The survey was conducted from April 18–30 2010 onboard two commercial fishing vessels. A DFO biologist and a contract biologist were present for the 13 days of surveying. No other dive fishery had operated in the area and relatively little was known about the habitat or environment in the PFMA Subareas.

PFMA Subarea 3–3 is located on the southwestern side of Wales Island, near the USA-Canada border. PFMA Subarea 3–6 makes up Work Channel. PFMA Subarea 3–7 is a large Subarea made up of the northeast coast of Somerville Island, the southeastern potion of Wales Island, the southern portion of Pearse Island, Union Inlet, Hogan Island and the Northern part of Work Channel. PFMA Subarea 3–8 is located in Steamer Passage. PFMA Subarea 3–9 encompasses Nasoga Gulf and PFMA Subarea 3–10 covers Khutzeymateen Inlet. The total shoreline length of all 6 PFMA Subareas was 486.1 km (measured via ArcGIS 9.3).

Area 3/4 Mainland

Area 3/4 Mainland is located in Pacific Fisheries Management Areas 3 and 4, which are in the North Coast region. The Area 3/4 Mainland survey was comprised of 8 PFMA Subareas: 3–4; 3–5; 4–5 to 4–9; and 4–14 (Figure 1). This survey was part of an effort to establish a new sea cucumber "no-take" reserve location. PFMA Subareas 3–4 and 3–5 are made up of the north and east coasts of Finlayson Island, Birnie Island, and Port Simpson. PFMA Subareas 4–5 and 4–9 are large Subareas in which only the eastern shoreline was included in this survey. The parts of Subarea 4–5 included in this survey were Hodgson Reefs, Burnt Cliff Island, the West coast of Finlayson Island and mainland segments between Big Bay and Hodgson Reefs. For analysis purposes, PFMA Subarea 4–5 was combined with PFMA Subarea 4–6, an area called Pearl Harbour, and PFMA Subarea 4–14, an area called Otter Anchorage. PFMA Subareas 4–7 and 4–8, the two Subareas that make up Big Bay, were surveyed but excluded from the analysis due to very low sea cucumber numbers and poor habitat. The parts of Subarea 4–9 included were the west coast of Digby Island, the Kinahan Islands, Tugwell Island, Metlakatla Bay, and Duncan Bay. The total shoreline length of all 8 PFMA Subareas was 183.3 km (160.0 km excluding 4–7 and 4–8; measured via ArcGIS 9.3).

Area 7 Mathieson

This survey was conducted off the Canadian Coast Guard vessel *Vector* May 14–23 2010. This survey was done in partnership with the Kitasoo Fishery Program. The entire survey area had been re-opened for the 2009–10 fishery, but had not been previously surveyed. The Area 7 Mathieson Open survey was made up of 5 PFMA Subareas (7–7, 7–9, 7–10, 7–11, and 7–29; Figure 1).

Pacific Fisheries Management Areas (PFMA) 7 is located in the Central Coast region of British Columbia. PFMA Subareas 7–7 comprises the northern tip of Mathieson Channel and Mussel Inlet. PFMA Subarea 7–9 is a very large Subarea; it comprises the southern stretches of Mathieson Channel, Oscar Passage, and Griffin Passage, as well as many islands including Lake Island and Cecilia Island. PFMA 7–10 is a central section of Mathieson Channel, between the entrance to Griffin Passage and the entrance into Kynoch Inlet. PFMA Subarea 7–11 is entirely made up of Kynoch Inlet. PFMA Subarea 7–29 is made up of Sheep Passage in the Northwest corner of the surveyed area. The total shoreline length of all five PFMA Subareas was 481.2 km (measured via ArcGIS 9.3).

Area 7–24

This survey was conducted off the Canadian Coast Guard vessel CCG *Vector* May 24 2010, immediately after the Area 7 Mathieson survey. The Area 7–24 Open survey encompassed a small PFMA Subarea near Bella Bella (Figure 1). It had been open since 1998 and sustained high levels of harvest activity. Of the static 73 un-surveyed PFMA Subareas open from 1998–2007, 7–24 had been designated the 2nd highest priority for surveying (Duprey et al. 2011).

PFMA Subarea 7–24 encompasses Raymond Pass on the northwest side of Campbell Island, Bella Bella is located on the northeast side of Campbell Island. The total shoreline length of PFMA Subarea 7–24 was 49.6 km (measured via ArcGIS 9.3).

Area 17

Pacific Fisheries Management Areas 17 is located in the East Coast of Vancouver Island region (Figure 1). In total seven Subareas were surveyed, PFMA 17 Subareas 3, 4, and 5, located in the northern part of the Gulf Islands and PFMA 17 Subareas 18, 19, 20, and 21 located north of Departure Bay near Nanaimo. The total length of the shoreline in the surveyed area was 120.7 km (measured via ArcGIS 9.3).

Area 7–14

PFMA Subarea 7–14 is located in the Central Coast and was the only permanent BioTransect location that was constructed and sampled in 2009–2010 (Figure 1). Area 7–14 was chosen as a Permanent BioTransect location because the PFMA Subarea had high levels of harvest activity (34th highest priority of unsurveyed open PFMA Subareas), yet was not an immediate priority for a full survey in the next few years. The Subarea encompasses all of Briggs Inlet, Bullock Channel and the northern sections of Spiller Channel. The total shoreline length of PFMA Subarea 7–14 was 231.9 km (measured via ArcGIS 9.3).

DATA ANALYSIS

Density estimations

For statistical analysis, the linear density of *P. californicus, C. miniata and C. pallida* for each transect was calculated by dividing the total number of sea cucumbers by the width of the transect (4 m for *P. californicus* and 2 m for *C. miniata* and *C. pallida*). On a Subarea basis, the transect data were analyzed using the CukeAnalysis Program (version 2008 11 19), which calculates the mean density and confidence bounds using the bootstrapping technique (see Hand et al. 2008 for more details). Transect data were re-sampled with 1000 iterations using a random seed of 756. Some PFMA Subareas were small and therefore had sample sizes too low to obtain good results from bootstrapping (a minimum of 10 transects is preferred). Analysis Areas were developed to avoid this complication: PFMA Subareas in the same survey were pooled with other PFMA Subareas that had similar bathymetry and geographical shape, and analyzed as one (see Table 1 for a list of Analysis Areas). The mean *P. californicus, C. miniata and C. pallida* density, and 75%, 90%, 95%, 99% confidence bounds were calculated for each Subarea or Analysis Area.

Mean weight estimations

Biosamples were used to obtain estimates of mean weight for each PFMA Subarea. The individual weights of each sea cucumber in a biosample (approximately 25 sea cucumbers) were averaged to produce a mean biosample weight from the sampled transect. The mean weight estimate for a Subarea is the mean of all the biosample averages collected from transects within that Subarea (Duprey et al. 2011). If no biosample was collected from a Subarea, the lowest mean weight estimate of all Subareas in the same survey was used (Duprey et al. 2011).

Biomass estimations

A Subarea's biomass is estimated at various confidence bounds (CB) using the following formula

$$\text{Biomass}_{CB} = [\text{Shoreline}_{\text{Protected}} * \text{Density}_{CB}) * \text{Wt}_{\text{mean}}] + [(\text{Shoreline}_{\text{Exposed}} * 2.5) * \text{Wt}_{\text{mean}}]$$

where Density_{CB} is the density from the bootstrap output and Wt_{mean} is the mean individual sea cucumber weight attributed to the Subarea from biosampling (Duprey et al. 2011). The shoreline length used to calculate biomass was measured using Compugrid and is currently housed in the managers database. $\text{Shoreline}_{\text{exposed}}$ is the accumulated shoreline in a Subarea that has been designated exposed in the BC Shorezone dataset (Hand et al. 2008; Duprey et al. 2011). $\text{Shoreline}_{\text{protected}}$ is the accumulated shoreline in a Subarea that has been designated Semi-Exposed to Very Protected (Duprey et al. 2011). If the Density_{CB} value is lower than 2.5 than 2.5 is replaced with the Density_{CB} value. More details on the methods used to calculate biomass estimations can be found in Duprey et al. (2011).

RESULTS

DENSITY SURVEYS

The following results are an analysis of the transect densities, biosample weights and biomass estimations for each Subarea. The actual density value for a transect can be found in Tables 5–9, while the figures indicate the position of a transect and use differing symbols for different density ranges. The density ranges developed for the figures were chosen because of their importance in the assessment of Analysis Areas. There are as many as five possible categories of density ranges in each figure; 0.00 sea cucumbers/metre (c/m-sh), and up to 2.49 c/m-sh are used in every figure in this report. Zero was chosen as a category to aid in determining areas where no sea cucumbers were seen. The next category range of 0.01 to 2.49 c/m-sh was chosen because a 90% lower confidence bound (LCB) of 2.50 c/m-sh, for an analysis area, is required before re-opening is recommended. The remaining three category ranges differ depending on where the survey was conducted and the results of the analysis. The next density range is between 2.50 c/m-sh and the lower of either the regional baseline density or the 90% LCB of the bootstrapped transect densities. Baseline densities are densities attributed to un-surveyed open areas within a region (Duprey et al. 2011). Current baseline densities for the four sea cucumber regions are: North Coast = 6.0 c/m-sh; Central Coast = 6.0 c/m-sh; East Coast Vancouver Island = 4.1 c/m-sh; and West Coast Vancouver Island = 1.9 c/m-sh (Duprey et al. 2011). The forth range is from the regional baseline density to the 90% LCB, or vice versa (or the maximum observed density in the Analysis Area if the 90% LCB is less than 2.5). The final range in the figures is from the 90% LCB (or regional baseline density) to the maximum density observed in the Analysis Area (if the maximum observed density is lower than the baseline density then this category is not present).

PFMA 3–3 (Area 3 South)

Parastichopus californicus

PFMA 3–3 had higher *P. californicus* densities in the northeastern segment of the Subarea (Figure 2). A total of 9 of the 22 transects surveyed had a density of less than 6.0 c/m-sh (Table 5). The highest transect density observed was 40.00 c/m-sh and the lowest 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total shoreline length for Subarea 3–3 of 42,588 m, all of which is classified as having Protected exposure in the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 11.6 c/m-sh with a 90% lower confidence bound (LCB) of 8.1 c/m-sh (Table 2). An average weight was calculated from each of the two biosamples (transects 234 and 240; Table 3); the average of these two values was 290 g (Table 3). The calculated 90% LCB of the estimated biomass was 100,039 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were only recorded for 10 of the 22 transects surveyed in the Subarea (transects 233–235 and 237–243). Two of the 10 transects surveyed had no observed *C. miniata* and the highest density observed was 41.50 c/m-sh (Table 5). The mean density was estimated to be 14.35 c/m-sh with a 90% LCB of 8.1 c/m-sh. Because only approximately half of the shoreline in Subarea 3–3 was surveyed for Cucumaria species, a corrected shoreline length of 23,478 m was used to estimate population size. Using the corrected shoreline length and the 90% LCB of the density, the estimated population of *C. miniata* was 190,172.

Eight of the 10 transects surveyed had no *C. pallida* observed and the highest density observed was 3.5 c/m-sh (Table 5). The mean density was estimated to be 0.4 c/m-sh with a 90% LCB of 0.0 c/m-sh. The calculated 90% LCB of the estimated population of *C. pallida* was 0 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected from all 22 transects surveyed in Subarea 3–3. Geoduck were not seen in high numbers in the Subarea; most of the transects had no or 'Few' geoducks observed. 'Abundant' numbers were seen on 1 (4%) transects, 'Many' were seen on 3 (14%) transects, and 'Few' were seen on 8 (36%) transects, while the remaining 10 (46%) transects had no observed geoducks (Figure 3).

Red sea urchin abundance was higher than that of green sea urchins in Subarea 3–3 (Figure 3). 'Abundant' red sea urchins were seen on 2 (9%) transects, 'Many' red sea urchins were seen on 9 (41%) transects, 'Few' on 1 (4%) transects and zero on the remaining 10 (46%) transects (Figure 3). 'Many' green sea urchins were seen on 2 (9%) transects, 10 (46%) transects had 'Few' and 10 (46%) transects had no green sea urchin observed.

PFMA 3–4 and 3–5 (Area 3/4 Mainland)

Parastichopus californicus

PFMA 3–4 and PFMA 3–5 were merged together as one Analysis Area. The density of *P. californicus* appears to be evenly distributed throughout the area there was a small clumping of low density transects in Stumaun Bay, which was mostly made up of PFMA 3–5 (Figure 4). A total of 8 of the 23 transects surveyed had a density of less than 6.0 c/m-sh (Table 6). The highest density observed was 51.75 c/m-sh and one transect had 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total shoreline length for Subarea 3–4 of 41,261 m, all of which is classified as Protected exposure by the BC Shorezone classification system. Subarea 3–5 had a shoreline length of 4,099 m which is also all classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 15.8 c/m-sh with a 90% lower confidence bound (LCB) of 11.1 c/m-sh (Table 2). An average weight was calculated from each of the two biosamples from PFMA 3–4 (transects 79 and 87; Table 3); the average of these two values was 281 g (Table 3). No biosamples were collected in PFMA 3–5, therefore 269g (the lowest Subarea weight calculated for the 3/4 Mainland survey) was used as the mean sea cucumber weight. The calculated 90% LCB of the estimated biomass for PFMA 3–4 was 128,697 kg and 12,239 kg for PFMA 3–5 (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 23 transects surveyed in the Subarea. Nine of the 23 transects surveyed had no *C. miniata* observed and the highest density observed was 96.0 c/m-sh (Table 6). The mean density was estimated to be 17.2 c/m-sh with a 90% LCB of 9.7 c/m-sh. Using the entire shoreline length of the Subareas and the 90% LCB of the density, the estimated population of *C. miniata* was 400,232 in Subarea 3–4 and 39,760 in Subarea 3–5.

Sixteen of the 23 transects surveyed had no *C. pallida* observed and the highest density observed was 3.5 c/m-sh (Table 6). The mean density was estimated to be 0.4 c/m-sh with a 90% LCB of 0.2 c/m-sh. Using the entire shoreline length of Subareas and the 90% LCB of the density, the estimated population of *C. pallida* was 8,252 individuals in Subarea 3–4 and 820 in Subarea 3–5.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected from all of the 23 transects surveyed in Subarea 3–4 and 3–5. Geoducks were seen in medium numbers in the Subareas (Figure 5). 'Abundant' numbers were seen on 1 (4%) transects, 'Many' were seen on 12 (55%) transects, 'Few' were seen on 2 (9%) transects and no geoducks were observed in the remaining 7 (32%) transects (no geoduck data were collected on 1 transect).

There were slightly more red sea urchins than green sea urchins in Subarea 3–4 and 3–5. 'Abundant' red sea urchins were seen on 1 (4%) transects, 'Many' were seen on 5 (23%) transects, 'Few' on 2 (9%) transects and zero on the remaining 14 (64%) transects (Figure 5). Green sea urchins were seen in 'Abundant' numbers on 1 (4%) transects, 'Many' were seen on 3 (14%) transects, 'Few' were seen on 1 (4%) transect and 17 (77%) transects had none observed (urchin data were not collected on 1 transect).

PFMA 3–6 (Area 3 South)

Parastichopus californicus

PFMA 3–6, Work Channel, had higher *P. californicus* densities in the northern segment and lower densities at the southern head of the channel and in Quotton Inlet, which is typical of large channels ending in tidal flats (Figure 6a, b). A total of 34 of the 79 transects surveyed had a density of less than 6.0 c/m-sh (Table 5). The highest density observed was 59.75 c/m-sh and the lowest 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 3–6 of 160,204 m, of which 3,596 m is classified as Exposed by the BC Shorezone classification system and therefore attributed a density of 2.5 c/m-sh. The remaining 156,608 m is Protected and attributed an estimated density from survey data.

Mean sea cucumber density was estimated to be 9.4 c/m-sh with a 90% lower confidence bound (LCB) of 7.8 c/m-sh (Table 2). An average weight was calculated from each of the seven biosamples (transects 14, 22, 39, 45, 55, 64, and 76; Table 3); the average of these seven values was 176 g (Table 3). The calculated 90% LCB of the estimated biomass was 216,574 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 79 transects surveyed in the Subarea. Forty-six of the 79 transects surveyed had no *C. miniata* observed and the highest density observed was 25.5 c/m-sh (Table 5). The mean density was estimated to be 2.5 c/m-sh with a 90% LCB of 1.7 c/m-sh. Using the entire shoreline length of Subarea 3–6 and the 90% LCB of the density, the estimated population of *C. miniata* was 272,346 sea cucumbers.

Forty-nine of the 79 transects surveyed had no *C. pallida* observed and the highest density observed was 42.0 c/m-sh (Table 5). The mean density was estimated to be 2.5 c/m-sh with a 90% LCB of 1.6 c/m-sh. Using the entire shoreline length of Subarea 3–6 and the 90% LCB of the density, the estimated population of *C. pallida* was 256,326 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected from all 79 transects surveyed in Subarea 3–6. Geoduck were not seen in high numbers in the Subarea; most of the transects had no or few geoducks observed. 'Many' were seen on 5 (6%) transects, 'Few' were seen on 8 (10%) transects and no geoducks were observed on 66 (84%) transects (Figure 7).

Red sea urchin abundance was lower than green sea urchins in Subarea 3–6 (Figure 7). 'Many' red sea urchins were seen on 5 (6%) transects, 'Few' on 5 (6%) transects and zero on the remaining 69 (87%) transects (Figure 7). 'Abundant' green sea urchins were seen on 10 transects, 'Many' were seen on 15 transects, 16 transects had 'Few' and zero on the remaining 38 (48%) transects.

PFMA 3–7 (Area 3 South)

Parastichopus californicus

PFMA 3–7 had higher *P. californicus* densities on the northern side of Somerville Island than anywhere else in the Subarea; there was a clumping of low density transects along the southern and eastern sides of Wales Island and the southern and western sides of Pearse Island (Figure 8). A total of 33 of the 63 transects surveyed had a density of less than 6.0 c/m-sh (Table 5). The highest density observed was 48.00 c/m-sh and the lowest was 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total shoreline length for Subarea 3–7 of 109,922 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 9.4 c/m-sh with a 90% lower confidence bound (LCB) of 7.6 c/m-sh (Table 2). An average weight was calculated from each of the six biosamples (transects 161, 175, 182, 193, 201, and 217; Table 3); the average of these six values was 212 g (Table 3). The calculated 90% LCB of the estimated biomass was 177,106 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 62 transects surveyed in the Subarea. Fifteen of the 62 transects surveyed had no *C. miniata* observed and the highest density observed was 395.5 c/m-sh (Table 5). The mean density was estimated to be 25.6 c/m-sh with a 90% LCB of 16.6 c/m-sh. Using the entire shoreline length of Subarea 3–7 and the 90% LCB of the density, the estimated population of *C. miniata* was 1,824,705 sea cucumbers.

Forty-one of the 62 transects surveyed had no *C. pallida* observed and the highest density observed was 24.5 c/m-sh (Table 5). The mean density was estimated to be 1.8 c/m-sh with a 90% LCB of 1.1 c/m-sh. Using the entire shoreline length of Subarea 3–7 and the 90% LCB of the density, the estimated population of *C. pallida* was 120,914 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected for all 63 transects surveyed in Subarea 3–7. Geoduck were not seen in high numbers in the Subarea; most transects had no geoducks observed (Figure 9). ‘Abundant’ geoducks were seen on 1 (2%) transect, ‘Many’ were seen on 4 (6%) transects, ‘Few’ were seen on 4 (6%) transects and no geoducks were observed on 53 (85%) transects (1 transect had no geoduck data recorded).

Red sea urchins were more abundant than green sea urchins in Subarea 3–7 (Figure 9). ‘Abundant’ red sea urchins were seen on 5 (8%) transects, ‘Many’ were seen on 16 (26%) transects, ‘Few’ on 5 (8%) transects and zero on the remaining 36 (58%) transects (1 transect had no red sea urchin data recorded). ‘Abundant’ green sea urchins were seen on 3 (5%) transects, ‘Many’ were seen on 11 (17%) transects, ‘Few’ on 22 (35%) transects and 27 (43%) transects had no green sea urchin observed.

PFMA 3–8 (Area 3 South)

Parastichopus californicus

PFMA 3–8 had higher *P. californicus* densities in the southern part of Steamer Passage and an area of low density transects in Somerville Bay and the northern entrance into Steamer Passage (Figure 10). A total of 8 of the 22 transects surveyed had a density of less than 6.0 c/m-sh (Table 5). The highest density observed was 61.25 c/m-sh and the lowest was 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 3–8 of 46,150 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 11.3 c/m-sh with a 90% lower confidence bound (LCB) of 7.6 c/m-sh (Table 2). An average weight was calculated from each of the two biosamples (transects 132, and 137; Table 3); the average of these two values was 245 g (Table 3). The calculated 90% LCB of the estimated biomass was 85,931 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 22 transects surveyed in the Subarea. Thirteen of the 22 transects surveyed had no *C. miniata* observed and the highest density observed was 55.5 c/m-sh (Table 5). The mean density was estimated to be 6.3 c/m-sh with a 90% LCB of 2.1 c/m-sh. Using the entire shoreline length of Subarea 3–8 and the 90% LCB of the density, the estimated population of *C. miniata* was 96,915 sea cucumbers.

Fifteen of the 22 transects surveyed had no *C. pallida* observed and the highest density observed was 57.5 c/m-sh (Table 5). The mean density was estimated to be 3.6 c/m-sh with a 90% LCB of 0.8 c/m-sh. Using the entire shoreline length of Subarea 3–8 and the 90% LCB of the density, the estimated population of *C. pallida* was 36,920 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected for all 22 transects surveyed in Subarea 3–8. Geoduck were not seen in high numbers in the Subarea, although over half of the transects had a few geoducks observed. 'Few' geoducks were seen on 13 (59%) transects and no geoducks were observed on 9 (41%) transects (Figure 11).

Red sea urchins were seen on fewer transects than green sea urchins in Subarea 3–8 (Figure 11). 'Many' red sea urchins were seen on 2 (9%) transects, 'Few' on 2 (9%) transects and zero on the remaining 18 (82%) transects. 'Many' green sea urchins were seen on 1 (4%) transect, 'Few' were seen on 7 (32%) transects and 14 (64%) transects had none observed.

PFMA 3–9 (Area 3 South)

Parastichopus californicus

PFMA 3–9 had higher *P. californicus* densities along the northern shore of the Nasoga Gulf (Figure 12). A total of 9 of the 16 transects surveyed had a density of less than 6.0 c/m-sh; the highest density observed was 31.5 c/m-sh and the lowest was 0 c/m-sh (Table 5); the low density transects were spread throughout the Subarea (Table 5).

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 3–9 of 23,386 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 10.4 c/m-sh with a 90% lower confidence bound (LCB) of 6.8 c/m-sh (Table 2). An average weight was calculated from each of the three biosamples (transects 140, 145, and 150; Table 3); the average of these three values was 229 g (Table 3). The calculated 90% LCB of the estimated biomass was 36,417 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 16 transects surveyed in the Subarea. Eight of the 16 transects surveyed had no *C. miniata* observed and the highest density observed was 35.0 c/m-sh (Table 5). The mean density was estimated to be 3.3 c/m-sh with a 90% LCB of 0.9 c/m-sh. Using the entire shoreline length of Subarea 3–9 and the 90% LCB of the density the estimated population of *C. miniata* was 21,047 sea cucumbers.

Ten of the 16 transects surveyed had no *C. pallida* observed and the highest density observed was 4.5 c/m-sh (Table 5). The mean density was estimated to be 0.9 c/m-sh with a 90% LCB of 0.4 c/m-sh. Using the entire shoreline length of Subarea 3–9 and the 90% LCB of the density the estimated population of *C. pallida* was 9,354 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected from 15 of the 16 transects surveyed in Subarea 3–8. Geoduck were seen in low numbers in the Subarea; most of the transects had either many or few geoducks observed. 'Many' geoducks were seen on 3 (20%) transects, 'Few' were seen on 6 (40%) transects and no geoducks were observed on 6 (40%) transects (Figure 13).

Red sea urchin abundance was lower than green sea urchin abundance in Subarea 3–8 (Figure 13). 'Many' red sea urchins were seen on 1 (7%) transect, 'Few' on 3 (20%) transects and zero on the remaining 11 (73%) transects. 'Many' green sea urchins were seen on 3 (20%) transects, 'Few' were seen on 5 (33%) transects and 7 (47%) transects had none observed.

PFMA 3–10 (Area 3 South)

Parastichopus californicus

PFMA 3–10 had higher *P.californicus* densities near the mid section of Khutzeymateen Inlet around Tsamspanaknok Bay and McGregor Point and there was a clumping of low density transects at the end of the Inlet (Figure 14). A total of 23 of the 33 transects surveyed had a density of less than 6.0 c/m-sh; the highest density observed was 17.25 c/m-sh and 8 transects had 0 c/m-sh (Table 5).

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 3–10 of 67,822 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 4.6 c/m-sh with a 90% lower confidence bound (LCB) of 3.2 c/m-sh (Table 2). An average weight was calculated from each of the three biosamples (transects 92, 102, and 111; Table 3); the average of these three values was 249 g (Table 3). The calculated 90% LCB of the estimated biomass was 54,041 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 33 transects surveyed in the Subarea. Twenty-six of the 33 transects surveyed had no *C. miniata* observed and the highest density observed was 19.5 c/m-sh (Table 5). The mean density was estimated to be 1.3 c/m-sh with a 90% LCB of 0.5 c/m-sh. Using the entire shoreline length of Subarea 3–10 and the 90% LCB of the density, the estimated population of *C. miniata* was 33,911 sea cucumbers.

Twenty-three of the 33 transects surveyed had no *C. pallida* observed and the highest density observed was 15.5 c/m-sh (Table 5). The mean density was estimated to be 1.4 c/m-sh with a 90% LCB of 0.7 c/m-sh. Using the entire shoreline length of Subarea 3–10 and the 90% LCB of the density, the estimated population of *C. pallida* was 47,475 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected from all 33 transects surveyed in Subarea 3–10. Geoduck were seen on only 1 (3%) transect and the remaining 32 transects (97%) had no geoducks observed (Figure 15).

Red sea urchin abundance was lower than green sea urchin abundance in Subarea 3–10 (Figure 15). 'Few' red sea urchins were seen on 1 (3%) transect and zero on the remaining 32 (97%) transects. 'Many' green sea urchins were seen on 3 (9%) transects, 'Few' were seen on 10 (30%) transects and 20 (61%) transects had none observed.

PFMA 4–5, 4–6, 4–7, 4–8, and 4–14 (Area 3/4 Mainland)

Parastichopus californicus

PFMA 4–5, 4–6, 4–7, 4–8 and 4–14 were merged together as one Analysis Area. The density of *P. californicus* in PFMA 4–5 was well distributed with mostly strong densities over 6.0 c/m-sh (Figure 16a, b). PFMA 4–7 and 4–8, which make up Big Bay (Figure 16d), had very low densities with 6 of the 8 transects having no sea cucumbers observed. Big Bay is mostly mud flats and fine sand, a habitat in which sea cucumbers are usually seen in very low densities or not at all. As a result, all 8 transects in PFMA 4–7 and 4–8 were excluded from further analysis. PFMA 4–14 and 4–6 are small Subareas and had only two transects each; they were therefore combined with PFMA 4–5 for analysis. All further discussion of results for this Analysis Area is pertinent only for FMA 4–5, 4–6 and 4–14.

A total of 4 of the 22 transects surveyed had a density of less than 6.0 c/m-sh (Figure 16a, b, c). The highest density observed was 64.25 c/m-sh and the lowest was 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 4–5 of 41,261 m, 83 m of which is exposed and receives a density of 2.5 c/m-sh while the remainder is classified as Protected by the BC Shorezone classification system. PFMA 4–6 and 4–14 shoreline lengths are 4,519 m and 3,108, respectively, all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 20.6 c/m-sh with a 90% lower confidence bound (LCB) of 15.2 c/m-sh (Table 2). In PFMA 4–5 an average weight was calculated from each of the two biosamples (transects 45 and 68; Table 3); the average of these two values was 319 g (Table 3). No biosamples were collected from PFMA 4–6 and 4–14, therefore 269 g (the lowest Subarea weight calculated for the 3/4 Mainland survey) was used as the mean sea cucumber weight for these Subareas. The 90% LCB of estimated biomass was 518,262 kg for Subarea 4–5, 18,477 kg for Subarea 4–6 and 12,708 kg for Subarea 4–14 (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 22 transects surveyed in the Subarea. Five of the 22 transects surveyed had no *C. miniata* observed and the highest density observed was 166.0 c/m-sh (Table 6). The mean density was estimated to be 33.2 c/m-sh with a 90% LCB of 19.6 c/m-sh. Using the entire shoreline length of each Subarea and the 90% LCB of the density, the estimated population of *C. miniata* was 808,716 sea cucumbers in Subarea 4–5, 88,572 sea cucumbers in Subarea 4–6, and 60,917 sea cucumbers in Subarea 4–14.

Nineteen of the 22 transects surveyed had no *C. pallida* observed and the highest density observed was 8.0 c/m-sh (Table 6). The mean density was estimated to be 0.8 c/m-sh with a 90% LCB of 0.2 c/m-sh. Using the entire shoreline length of each Subarea and the 90% LCB of the density, the estimated population of *C. pallida* was 8,252 sea cucumbers in Subarea 4–5, 904 sea cucumbers in Subarea 4–6, and 622 sea cucumbers in Subarea 4–14.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected from 21 of the 22 transects surveyed in Subarea 4–5, 4–6 and 4–14. Geoduck were not seen in high numbers in the Subarea. 'Abundant' geoducks were seen on 8 (38%) transects, 'Few' were seen on 6 (28%) transects and none were observed on the remaining 7 (33%) transects (Figure 17a, b, c).

There were slightly more red sea urchins than green sea urchins in Subareas 4–5, 4–6 and 4–14 (2 transects had no urchin data recorded; Figure 17a, b, c). 'Abundant' red sea urchins were seen on 2 (11%) transects, 'Many' on 6 (32%) transects, 'Few' on 1 (5%) transects and zero on the remaining 10 (53%) transects (Figure 17a, b, c). 'Abundant' green sea urchins were seen on 1 (5%) transect, 4 (21%) transects had 'Many', 3 (16%) transects had 'Few' and 11 (58%) transects had no green sea urchin observed.

PFMA 4–9 (Area 3/4 Mainland)

Parastichopus californicus

PFMA 4–9 had high *P. californicus* densities along the western side of Digby Island and there was a clumping of low density transects inside Duncan Bay and around Kinahan Islands (Figure 18a, b). A total of 15 of the 36 transects surveyed had a density of less than 6.0 c/m-sh (Figure 18a, b). The highest density observed was 60.25 c/m-sh and the lowest was 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 4–9 of 49,783 m; of this area 959 m is classified as Exposed and the remainder is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 11.7 c/m-sh with a 90% lower confidence bound (LCB) of 9.0 c/m-sh (Table 2). An average weight was calculated from each of the four biosamples (transects 2, 16, 26 and 31; Table 3); the average of these four values was 269 g (Table 3). The calculated 90% LCB of the estimated biomass was 118,848 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* presence was only recorded for 26 of the 36 transects surveyed in the Subarea (transects 4–16, 19–20, 23, and 27–36). Seven of the 26 transects surveyed had no *C. miniata* observed and the highest density observed was 64.5 c/m-sh (Table 6). The mean density was estimated to be 12.8 c/m-sh with a 90% LCB of 8.0 c/m-sh. Using the entire shoreline length of Subarea 4–9 and the 90% LCB of the density, the estimated population of *C. miniata* was 398,264 sea cucumbers.

Nineteen of the 26 transects surveyed had no *C. pallida* observed and the highest density observed was 2.5 c/m-sh (Table 6). The mean density was estimated to be 0.3 c/m-sh with a 90% LCB of 0.1 c/m-sh. Using the entire shoreline length of Subarea 4–9 and the 90% LCB of the density, the estimated population of *C. pallida* was calculated to be 4,978 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected from 34 of the 36 transects surveyed in Subarea 4–9. Geoduck were not seen in high numbers in the Subarea; most of the transects had no geoducks observed. 'Abundant' numbers were seen on 1 (3%) transects, 'Many' were seen on 6 (18%) transects, and 'Few' were seen on 9 (27%) transects; in the remaining 17 (51%) transects no geoducks were observed (no geoduck data were collected on 1 transect; Figure 19).

There were slightly more red sea urchins than green sea urchins in Subarea 7–10 (Figure 19). 'Abundant' red sea urchins were seen on 7 (21%) transects, 'Many' were seen on 8

(24%) transects, 'Few' on 6 (18%) transects and zero on the remaining 13 (38%) transects (Figure 19). 'Abundant' green sea urchins were seen on 5 (15%) transects, 6 (18%) transects had 'Many', 6 (18%) transects had 'Few', and 17 (50%) transects had no green sea urchin observed.

PFMA 7–7 (Area 7 Mathieson)

Parastichopus californicus

PFMA 7–7 had high *P. californicus* densities along the southern side of Mussel Inlet, while there was a clumping of low density transects at the head and northern shores of Mussel Inlet (Figure 20). A total of 14 of the 31 transects surveyed had a density of less than 6.0 c/m-sh (Table 7). The highest density observed was 19.25 c/m-sh and the lowest was 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 7–7 of 54,314 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 7.8 c/m-sh with a 90% lower confidence bound (LCB) of 6.0 c/m-sh (Table 2). An average weight was calculated from each of the three biosamples (transects 192, 202 and 211; Table 3); the average of these three values was 206 g (Table 3). The calculated 90% LCB of the estimated biomass was 67,132 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 31 transects surveyed in the Subarea. Twelve of the 31 transects surveyed had no *C. miniata* observed and the highest density observed was 76.0 c/m-sh (Table 7). The mean density was estimated to be 12.7 c/m-sh with a 90% LCB of 7.4 c/m-sh. Using the entire shoreline length of Subarea 7–7 and the 90% LCB of the density, the estimated population of *C. miniata* was 401,924 sea cucumbers.

Fourteen of the 31 transects surveyed had no *C. pallida* observed and the highest density observed was 97.5 c/m-sh (Table 7). The mean density was estimated to be 15.3 c/m-sh with a 90% LCB of 9.1 c/m-sh. Using the entire shoreline length of Subarea 7–7 and the 90% LCB of the density, the estimated population of *C. pallida* was calculated to be 494,257 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected all of the 31 transects surveyed in Subarea 7–7. Geoduck were seen in high numbers in the Subarea. 'Abundant' geoduck were seen on 11 (35%) transects, 4 (13%) transects had 'Many', and 9 (29%) transects had 'Few'; in the remaining 7 (23%) transects no geoducks were observed (Figure 21).

Red sea urchins were observed in high numbers in the southern part of Subarea 7–7. 'Abundant' red sea urchins were seen on 2 (6%) transects, 'Many' were seen on 6 (19%) transects, 'Few' on 12 (39%) transects and zero on the remaining 11 (35%) transects

(Figure 21). Green sea urchins were seen in higher numbers than red sea urchin throughout the Subarea. 'Abundant' green sea urchins were seen on 11 (35%) transects, 4 (13%) transects had 'Many', 9 (29%) transects had 'Few' and only 7 (23%) transects had no green sea urchin observed.

PFMA 7–9 (Area 7 Mathieson)

Parastichopus californicus

PFMA 7–9 had high *P. californicus* densities along the main section of Mathieson Channel and there was a clumping of low density transects at the southern exposed section of the Subarea around Cecilia Island (Figure 22a, b, c). A total of 38 of the 111 transects surveyed had a density of less than 6.0 c/m-sh (Table 7). The highest density observed was 59.25 c/m-sh and the lowest was 0 c/m-sh.

A total of 27,301 m of shoreline was excluded as Griffin Passage was non-navigable and poor sea cucumber habitat. Two areas are closed to sea cucumber fishing in PFMA Subarea 7–9; Jackson Passage is a no-take reserve that consists of 29,995 m of shoreline and the Berry Inlet Experimental Fishery Area that consists of 24,855 m of shoreline. The DFO management database has a total length for Subarea 7–9 of 281,014 m; after excluding the two closures and the segment of Griffin Passage that was unfishable a total fishable shoreline of 198,861 m. Of this fishable shoreline 198,702 m is classified as Protected and 159 m is classified as Exposed by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 11.2 c/m-sh with a 90% lower confidence bound (LCB) of 9.7 c/m-sh (Table 2). An average weight was calculated from each of the 12 biosamples (transects 8, 15, 21, 38, 52, 61, 69, 75, 87, 96, 104, and 115; Table 3); the average of these 12 values was 251 g (Table 3). The calculated 90% LCB of the estimated biomass was 483,880 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 111 transects surveyed in the Subarea. Twenty-five of the 111 transects surveyed had no *C. miniata* observed and the highest density observed was 94.0 c/m-sh (Table 7). The mean density was estimated to be 12.0 c/m-sh with a 90% LCB of 9.2 c/m-sh. Using 198,861 m as the shoreline length of Subarea 7–9 and the 90% LCB as the estimated density, the estimated population of *C. miniata* was 1,829,521 sea cucumbers.

Thirty-one of the 111 transects surveyed had no *C. pallida* observed and the highest density observed was 134.0 c/m-sh (Table 7). The mean density was estimated to be 22.0 c/m-sh with a 90% LCB of 17.3 c/m-sh. Using 198,861 m as the shoreline length of Subarea 7–9 and the 90% LCB as the estimated density, the estimated population of *C. pallida* was 3,440,295 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative geoduck abundance data were collected on 109 of the 111 transects surveyed in Subarea 7–9. Geoducks were not seen in high numbers in the Subarea; most transects had no geoducks observed. 'Abundant' numbers were seen on 10 (9%)

transects, 'Many' were seen on 16 (15%) transects, and 'Few' were seen on 12 (11%) transects; in the remaining 71 (65%) transects no geoducks were observed (Figure 23).

Sea urchin abundance data were collected on all of the 111 transects surveyed in Subarea 7–9. Red sea urchins were observed in higher numbers than green sea urchin throughout the southern part of Subarea 7–9 (Figure 23). 'Abundant' red sea urchins were seen on 35 (32%) transects, 'Many' were seen on 35 (32%) transects, 'Few' were seen on 19 (17%) transects and zero on the remaining 22 (20%) transects (Figure 23). Green sea urchins were consistently seen in lower numbers than red sea urchin throughout the Subarea. 'Abundant' numbers were seen on 19 (17%) transects, 21 (19%) transects had 'Many', 40 (36%) transects had 'Few' and only 31 (28%) transects had no green sea urchin observed.

PFMA 7–10 (Area 7 Mathieson)

Parastichopus californicus

PFMA 7–10 had evenly distributed *P. californicus* densities throughout the channel (Figure 24). A total of 9 of the 29 transects surveyed had a density of less than 6.0 c/m-sh (Table 7). The highest density observed was 33.75 c/m-sh and the lowest was 1.5 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 7–10 of 46,721 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 13.0 c/m-sh with a 90% lower confidence bound (LCB) of 10.8 c/m-sh (Table 2). An average weight was calculated from each of the two biosamples (transects 139 and 145; Table 3); the average of these two values was 177 g (Table 3). The calculated 90% LCB of the estimated biomass was 89,312 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 29 transects surveyed in the Subarea. Six of the 29 transects surveyed had no *C. miniata* observed and the highest density observed was 37.5 c/m-sh (Table 7). The mean density was estimated to be 8.7 c/m-sh with a 90% LCB of 5.9 c/m-sh. Using the entire shoreline length of Subarea 7–10 and the 90% LCB of the density, the estimated population of *C. miniata* was 275,654 sea cucumbers.

Eight of the 29 transects surveyed had no *C. pallida* observed and the highest density observed was 148.5 c/m-sh (Table 7). The mean density was estimated to be 32.2 c/m-sh with a 90% LCB of 23.0 c/m-sh. Using the entire shoreline length of Subarea 7–10 and the 90% LCB of the density, the estimated population of *C. pallida* was 1,074,583 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected on all of the 29 transects surveyed in Subarea 7–10. Geoduck were not seen in high numbers in the Subarea; most of the transects had no geoducks observed. 'Abundant' numbers were seen on 1 (3%) transect, 'Many' on 2 (7%) transects, and 'Few' on 2 (7%) transects; in the remaining 24 (83%) transects no geoducks were observed (Figure 25).

Red sea urchins were observed in lower numbers than green sea urchin in Subarea 7–10 (Figure 25). 'Many' red sea urchins were seen on 12 (41%) transects, 'Few' on 9 (31%) transects and zero on the remaining 8 (28%) transects (Figure 25). Green sea urchins were seen in 'Abundant' numbers on 13 (45%) transects, 'Many' on 7 (24%) transects, 'Few' on 5 (17%) transects and only 4 (14%) transects had no green sea urchin observed.

PFMA 7–11 (Area 7 Mathieson)

Parastichopus californicus

PFMA 7–11 had a clump of lower *P. californicus* densities in the southeastern corner of the Subarea (Figure 26). A total of 11 of the 23 transects surveyed had a density of less than 6.0 c/m-sh (Table 7). The highest density observed was 18.25 c/m-sh and the lowest was 0.5 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 7–11 of 56,851 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 7.1 c/m-sh with a 90% lower confidence bound (LCB) of 5.7 c/m-sh (Table 2). An average weight was calculated from each of the two biosamples (transects 156 and 161; Table 3); the average of these two values was 255 g (Table 3). The calculated 90% LCB of the estimated biomass was 82,633 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 23 transects surveyed in the Subarea. Seven of the 23 transects surveyed had no *C. miniata* observed and the highest density observed was 88.5 c/m-sh (Table 7). The mean density was estimated to be 8.9 c/m-sh with a 90% LCB of 4.3 c/m-sh. Using the entire shoreline length of Subarea 7–11 and the 90% LCB of the density, the estimated population of *C. miniata* was 244,459 sea cucumbers.

Eight of the 23 transects surveyed had no *C. pallida* observed and the highest density observed was 164.0 c/m-sh (Table 7). The mean density was estimated to be 15.0 c/m-sh with a 90% LCB of 5.8 c/m-sh. Using the entire shoreline length of Subarea 7–11 and the 90% LCB of the density, the estimated population of *C. pallida* was 329,736 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected on all of the 23 transects surveyed in Subarea 7–11. Geoducks were not seen in high numbers in the Subarea; most transects had no geoducks observed. 'Abundant' numbers were seen on 1 (4%) transect, in the remaining 22 (96%) transects no geoducks were observed (Figure 27).

Red sea urchins were observed in lower numbers than green sea urchin in the Subarea (Figure 27). 'Many' red sea urchins were seen on 8 (35%) transects, 'Few' on 10 (43%) transects and zero on the remaining 5 (22%) transects (Figure 27). Green sea urchins were seen in 'Abundant' numbers on 9 (39%) transects, 'Many' on 6 (26%) transects, 'Few' on 3 (13%) transects and zero on the remaining 5 (22%) transects.

PFMA 7–24 (Area 7–24)

Parastichopus californicus

PFMA 7–24 had consistently high *P. californicus* densities that were well distributed with no observable regional clumping. The southwestern section of the Subarea may be an area of lower density, but this is hard to confirm with only 2 low density transects in the area (Figure 28). A total of 5 of the 26 transects surveyed had a density of less than 6.0 c/m-sh (Table 8). The highest density observed was 30.25 c/m-sh and the lowest 0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 7–24 of 40,858 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 12.0 c/m-sh with a 90% lower confidence bound (LCB) of 9.7 c/m-sh (Table 2). An average weight was calculated from each of the three biosamples (transects 6, 10 and 23; Table 3); the average of these three values was 277 g (Table 3). The calculated 90% LCB of the estimated biomass was 109,781 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 26 transects surveyed in the Subarea. Five of the 26 transects surveyed had no *C. miniata* observed and the highest density observed was 47.5 c/m-sh (Table 8). The mean density was estimated to be 9.7 c/m-sh with a 90% LCB of 6.3 c/m-sh. Using the entire shoreline length of Subarea 7–24 and the 90% LCB of the density, the estimated population of *C. miniata* was 257,405 sea cucumbers.

Six of the 26 transects surveyed had no *C. pallida* observed and the highest density observed was 33.5 c/m-sh (Table 8). The mean density was estimated to be 8.7 c/m-sh with a 90% LCB of 5.9 c/m-sh. Using the entire shoreline length of Subarea 7–24 and the 90% LCB of the density, the estimated population of *C. pallida* was 241,062 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected on all of the 26 transects surveyed in Subarea 7–24. Geoduck were common in the Subarea. 'Abundant' geoducks were seen on 5 (19%) transects, 'Many' were seen on 7 (27%) transects, and 'Few' on 3 (12%) transects; in the remaining 11 (42%) transects no geoducks were observed (Figure 29).

Red sea urchins were observed in small numbers in Subarea 7–24. 'Many' red sea urchin were seen on 2 (8%) transects, 'Few' on 12 (46%) transects and zero on the remaining 12 (46%) transects (Figure 29). Green sea urchins were seen in higher numbers than red sea urchin throughout the Subarea. 'Abundant' green sea urchins were seen on 5 (19%) transects, 8 (31%) transects had 'Many', 7 (27%) transects had 'Few' and only 6 (23%) transects had no green sea urchin observed (Figure 29).

PFMA 7–29 (Area 7 Mathieson)

Parastichopus californicus

PFMA 7–29 had a slight clump of lower *P. californicus* transect densities in the southwestern corner of the Subarea (Figure 30). A total of 6 of the 27 transects surveyed had a density of less than 6.0 c/m-sh (Table 7). The highest density observed was 54.00 c/m-sh and the lowest was 0.25 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 7–29 of 43,898 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 14.8 c/m-sh with a 90% lower confidence bound (LCB) of 11.6 c/m-sh (Table 2). An average weight was calculated from each of the three biosamples (transects 216, 226 and 239; Table 3); the average of these three values was 170 g (Table 3). The calculated 90% LCB of the estimated biomass was 86,567 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* numbers were recorded on all 27 transects surveyed in the Subarea. Five of the 27 transects surveyed had no *C. miniata* observed and the highest density observed was 89.5 c/m-sh (Table 7). The mean density was estimated to be 16.7 c/m-sh with a 90% LCB of 9.6 c/m-sh. Using the entire shoreline length of Subarea 7–29 and the 90% LCB of the density, the estimated population of *C. miniata* was 421,420 sea cucumbers.

Eight of the 27 transects surveyed had no *C. pallida* observed and the highest density observed was 64.5 c/m-sh (Table 7). The mean density was estimated to be 12.4 c/m-sh with a 90% LCB of 7.6 c/m-sh. Using the entire shoreline length of Subarea 7–29 and the 90% LCB of the density, the estimated population of *C. pallida* was 333,625 sea cucumbers.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data were collected on all of the 27 transects surveyed in Subarea 7–29. Geoduck were not seen in high numbers in the Subarea; most of the transects had no geoducks observed. 'Many' were seen on 1 (4%) transect and 'Few' were seen on 5 (19%) transects; in the remaining 21 (78%) transects no geoducks were observed (Figure 31).

Red sea urchins were observed in lower numbers than green sea urchin in the Subarea (Figure 31). 'Abundant' red sea urchins were seen on 1 (4%) transect, 'Many' were seen on 7 (26%) transects, 'Few' on 12 (44%) transects and zero on the remaining 7 (26%) transects (Figure 31). Green sea urchins were seen in 'Abundant' numbers on 7 (26%) transects, 'Many' on 6 (22%) transects, 'Few' on 11 (41%) transects and 3 (11%) transects had no green sea urchin observed.

PFMA 17–3 (Area 17)

Parastichopus californicus

PFMA 17–3 had consistently low *P. californicus* densities throughout (Figure 32). A total of 8 of the 11 transects surveyed had a density of less than 6.0 c/m-sh (Table 9). The highest density observed was 37.0 c/m-sh and the lowest 0 c/m-sh; however this high density transect appears to be an outlier for the Subarea as the second highest density was 8.0 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 17–3 of 19,471 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 5.7 c/m-sh with a 90% lower confidence bound (LCB) of 2.3 c/m-sh (Table 2). An average weight was calculated from the one biosample collected from transects 30; the mean weight was 291 g (Table 3). The calculated 90% LCB of the estimated biomass was 13,032 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* presence was not recorded during this survey.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data was not recorded consistently throughout the Area 17 survey. Therefore results are not presented as there would be a high degree of bias towards transects were animals were seen.

PFMA 17–4 (Area 17)

Parastichopus californicus

PFMA 17–4 had consistently low *P. californicus* densities throughout the Subarea (Figure 33). A total of 12 of the 14 transects surveyed had a density of 0.0 c/m-sh (Table 9). The lowest density observed was 0.00 c/m-sh and the highest 1.75 c/m-sh, well below the regional baseline density of 4.1 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 17–4 of 30,962 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 0.1 c/m-sh with a 90% lower confidence bound (LCB) of 0.0 c/m-sh (Table 2). There was no biosamples collected in the Subarea.

Following the methods prescribed in Duprey et al. (2011) the lowest biosample weight in the Area 17 survey, 218 g, was used to calculate biomass (Table 3). The calculated 90% LCB of the estimated biomass was 0 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* presence was not recorded during this survey.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data was not recorded consistently throughout the Area 17 survey. Therefore results are not presented as there would be a high degree of bias towards transects were animals were seen.

PFMA 17–5 (Area 17)

Parastichopus californicus

PFMA 17–5 had consistently low *P. californicus* densities throughout the Subarea (Figure 34). All of the 11 transects surveyed had a density less than 2.0 c/m-sh (Table 9). The lowest density observed was 0.00 c/m-sh and the highest was 1.75 c/m-sh, well below the regional baseline density of 4.10 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 17–5 of 23,906 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 0.4 c/m-sh with a 90% lower confidence bound (LCB) of 0.1 c/m-sh (Table 2). There were no biosamples collected in the Subarea. Following the methods prescribed in Duprey et al. (2011) the lowest biosample weight in the Area 17 survey, 218 g, was used to calculate biomass (Table 3). The calculated 90% LCB of the estimated biomass was 521 kg (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* presence was not recorded during this survey.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data was not recorded consistently throughout the Area 17 survey. Therefore results are not presented as there would be a high degree of bias towards transects were animals were seen.

PFMA 17–18 and 21 (Area 17)

Parastichopus californicus

PFMA 17–18 and 21 had the highest *P. californicus* densities seen in the Area 17 survey (Figure 35). A total of 5 of the 16 transects surveyed had a density of less than 4.1 c/m-sh (Table 9). The highest density observed was 49.50 c/m-sh and the lowest 0.00 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 17–18 of 31,869 m, 29,770 m classified as Protected and 2,099 m classified as Exposed by the BC Shorezone classification system. The DFO management database has a total length for Subarea 17–21 of 2,722 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 12.5 c/m-sh with a 90% lower confidence bound (LCB) of 8.1 c/m-sh (Table 2). An average weight was calculated for PFMA 17–18 from the one biosample collected (transects 53); the mean weight was 234 g (Table 3). An average weight was calculated for PFMA 17–21 from the one biosample collected (transects 39); the mean weight was 218 g (Table 3). The calculated 90% LCB of the estimated biomass was 57,654 kg for Subarea 17–18 and 4,807 kg for Subarea 17–21 (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* presence was not recorded during this survey.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data was not recorded consistently throughout the Area 17 survey. Therefore results are not presented as there would be a high degree of bias towards transects were animals were seen.

PFMA 17–19 and 20 (Area 17)

Parastichopus californicus

PFMA 17–19 and 20 had consistently low *P. californicus* densities within the bay, with higher densities on the outer islands (Figure 36). A total of 6 of the 9 transects surveyed had a density of less than 1.0 c/m-sh (Table 9). The highest density observed was 7.00 c/m-sh and the lowest 0.00 c/m-sh.

No shoreline segments were excluded due to logistical obstacles or other closures. The DFO management database has a total length for Subarea 17–19 of 7,627 m, 5,042 m classified as Protected and 2,585 m classified as Exposed by the BC Shorezone classification system. The DFO management database has a total length for Subarea 17–20 of 7,896 m, 6,206 m classified as Protected and 1,690 m classified as Exposed by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 2.1 c/m-sh with a 90% lower confidence bound (LCB) of 0.7 c/m-sh (Table 3). There were no biosamples collected in either Subarea. Following the methods prescribed in Duprey et al. (2011) the lowest biosample weight in the Area 17 survey, 218 g, was used to calculate biomass estimates (Table 2). The calculated 90% LCB of the estimated biomass was 2,178 kg for Subarea 17–19 and 1,868 kg for Subarea 17–20 (Table 4).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* presence was not recorded during this survey.

Geoduck, red sea urchin and green sea urchin abundance

Relative abundance data was not recorded consistently throughout the Area 17 survey. Therefore results are not presented as there would be a high degree of bias towards transects were animals were seen.

PERMANENT BIOTRANSECTS

PFMA 7–14

Parastichopus californicus

Nine permanent BioTransects were established randomly throughout Subarea 7–14. The number of *P. californicus* collected from each BioTransect ranged from 1 (transect 94) to 100 (transect 82). Each permanent BioTransect was averaged and the mean weight for the Subarea estimated as the mean of the BioTransect averages (Duprey et al. 2011). The Subarea's mean weight was 272 g (Table 3).

Cucumaria miniata and C. pallida

Cucumaria miniata and *C. pallida* are not recorded while collecting permanent BioTransect data.

Geoduck, red sea urchin and green sea urchin abundance

Geoduck, red sea urchin and green sea urchin relative abundance is not recorded while collecting permanent BioTransects.

DISCUSSION

AREA 3 SOUTH

The density estimates of *P. californicus* for Area 3 South were high and all but one Subarea had 90% lower confidence bounds (LCB) greater than 6.0 c/m-sh, which is the baseline density estimate for the North Coast. In accordance with the sea cucumber assessment framework (Duprey et al. 2011), if Subareas in the Area 3 South survey are to be opened, it is recommended that the 90% LCBs of mean estimated density and the mean weight estimates presented here be used to calculate biomass estimates.

Subarea 3–9, the Nasoga Gulf, is recommended as an ideal location for a no-take reserve. The Subarea has representative *P. californicus* densities and can be easily distinguished geographically. In addition, the other two species of sea cucumbers plus green sea urchins, red sea urchins and geoducks are all present throughout the gulf on multiple transects.

AREA 3/4 MAINLAND

Big Bay, located south of Finlayson Island in the northern section of the survey area, was entirely poor sea cucumber habitat. Most of the substrate was mud and 75% of the transects surveyed in the bay had no sea cucumbers. For this reason, the data from the two Subareas that make up this bay, Subareas 4–7 and 4–8, were excluded from analysis and it is recommended that these areas not be open to commercial harvesting. The density estimates from the remainder of Area 3/4 Mainland were very high, with all

Subareas having 90% lower confidence bound (LCB) densities above 6.0 c/m-sh. If the Subareas in the Area 3/4 Mainland survey are to be opened for commercial fishing, it is recommended that the 90% LCBs of mean estimated density and the mean weight estimates presented here be used to estimate the biomass.

An additional objective of this survey was to recommend parts of the area to be set aside as a no-take reserve. The Subareas 3–4, 3–5 and 4–9 would make good reserves as they have representative densities and are a mix of more exposed and sheltered habitats. Also, the geographical positions of these three Subareas would achieve the secondary goal of having a network of coastal sea cucumber no-take reserves in the North Coast. Green sea urchins, red sea urchins and geoducks are also found on multiple transects throughout these three Subareas.

AREA 7 MATHIESON

The survey results for Area 7 Mathieson indicate densities overall were high, with only one Subarea having a 90% lower confidence bound (LCB) density less than 6.0 c/m-sh. The Area 7 Mathieson survey area had been re-opened for the 2009–2010 fishing season with a baseline density of 6.0 c/m-sh for each Subarea. In accordance with the sea cucumber assessment framework (Duprey et al. 2011), it is recommend that the 90% LCBs of the mean estimated density for Subareas 7–7, 7–9, 7–10, 7–11 and 7–29 replace the baseline density estimate of 6.0 c/m-sh. The survey results presented here indicate that the density of *P. californicus* was substantially higher than the baseline estimate in Subareas 7–9 (+62%), 7–10 (+80%) and 7–29 (+93%). The results for Subarea 7–7 were identical to the previously allocated baseline density. Subarea 7–11, Kynoch Inlet, had a 90% LCB density estimate slightly lower (-5%) than the previously allocated baseline density.

A baseline estimate of 0.280 kg mean weight was used previously to calculate the estimated biomass in these Subareas. The mean weight estimates from biosamples collected in the Subareas were all lower than the baseline estimate; 7–7 (-26%), 7–9 (-10%), 7–10 (-37%), 7–11 (-9%) and 7–29 (-39%). It is recommended these new mean weight estimates be used for all biomass calculations. A no-take reserve was already established in Jackson Passage when fishing originally began in these Subareas.

AREA 7–24

The estimated density for Area 7–24 was higher than previously-used baseline density estimate of 6.0 c/m-sh. This Subarea has been harvested annual since 1998 and was targeted for surveying due to its high landings to shoreline ratio. The Subarea was ranked as the 2nd most important open Subarea for surveying by Duprey et al. (2011). It is recommended that the 90% LCBs of the survey results presented here be used to calculate biomass estimates.

A baseline estimate of 0.297 kg mean weight was also used previously to calculate the estimated biomass in the Subarea; the mean results from biosamples collected in the Subarea were lower at 0.277 kg. It is recommended this new mean weight estimate be used for all biomass calculations.

Overall, the results of surveying this Subarea are encouraging, considering the large amount of landings and fishing effort that has been focused on the Subarea.

AREA 17

The density estimates for Area 17 were generally low and all but one Analysis Area had 90% lower confidence bound (LCB) densities above 2.5 c/m-sh. In accordance with the sea cucumber assessment framework (Duprey et al. 2011), if the estimated 90% LCB for a Subarea is less than 2.5 c/m-sh, it is recommended the area not be open for commercial harvesting. Therefore we recommend Subareas 17–3, 17–4, 17–5, 17–19 and 17–20 all remain closed to commercial harvesting activity. The density estimates for Subareas 17–18 and 17–21 had 90% LCB well above 2.5 c/m-sh and if these Subareas are to be opened, it is recommended that the 90% LCBs of the mean estimated density and the mean weight estimates presented here be used to estimate the Subarea biomass.

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Table 1. The number and ID of transects surveyed, and the number of *Parastichopus californicus* biosamples collected in Open Surveys conducted June 2009 – May 2010, by PFMA Subarea. The total shoreline length is measured from the cucland.shp dataset using ArcGIS 9.3. (Note this is different from the shoreline length used for biomass calculations, which was measured using Compugrid.)

Analysis Areas	Survey	PFMA Subareas	Shoreline Length (Km)	Number (and ID) of Transects	Biomsamples
1	Area 3 South	3–3	45.4	22 (TR 222–243)	2
2	Area 3/4 Mainland	3–4	44.6	21 (TR 63, 69–79, 82–90)	2
	Area 3/4 Mainland	3–5	4.4	2 (TR 80–81)	0
3	Area 3 South	3–6	160.9	79 (TR 1–80)	7
4	Area 3 South	3–7	130.7	63 (TR 156–221)	6
5	Area 3 South	3–8	52.6	22 (TR 114–139)	2
6	Area 3 South	3–9	31.3	16 (TR 140–155)	3
7	Area 3 South	3–10	65.2	33 (TR 81–113)	3
8	Area 3/4 Mainland	4–5	36.6	18 (TR 37–47; 57–57; 64–68)	2
	Area 3/4 Mainland	4–6	5.4	2 (TR 60, 62)	0
	Area 3/4 Mainland	4–7	5.8	3 (TR 53–55)	0
	Area 3/4 Mainland	4–8	11.5	5 (TR 48–52)	1
	Area 3/4 Mainland	4–14	2.8	2 (TR 59, 61)	0
9	Area 3/4 Mainland	4–9	72.2	36 (TR 1–36)	4
10	Area 7 Mathieson	7–7	63.1	31 (TR 184–215)	3
11	Area 7 Mathieson	7–9	260.9	111 (TR 1–130)	12
12	Area 7 Mathieson	7–10	57.2	29 (TR 131–159)	2
13	Area 7 Mathieson	7–11	48.8	23 (TR 160–183)	2
14	Area 7–24	7–24	49.6	26 (TR 1–26)	3
15	Area 7 Mathieson	7–29	51.2	27 (TR 216–242)	3
16	Area 17	17–3	20.5	11 (TR 27–37)	1
17	Area 17	17–4	25.8	14 (TR 1–14)	0
18	Area 17	17–5	23.7	11 (TR 15–26)	0
19	Area 17	16–10	28.4	14 (TR 40–53)	1
20	Area 17	16–11	3.1	2 (TR 38–39)	1
21	Area 17	16–12	11.5	6 (TR 54–56; 61–63)	0
22	Area 17	16–13	7.7	3 (TR 58–60)	0
	TOTAL	**27**	**1320.9**	**632**	**60**

Table 2. Mean linear *Parastichopus californicus* density estimates with confidence bounds (sea cucumbers per metre of shoreline: c/m-sh) from Open Surveys completed June 2009 – May 2010. Each PFMA Subarea was analyzed separately except those shown with *, **, †, or ‡ which indicates that the transects were pooled into Analysis Areas. The recommended estimate of density for calculating biomass estimates for PFMA Subareas is the lower 90% confidence bound (LCB) (Hand et al. 2008; Duprey et al. 2011).

PFMA Subarea	Survey	No. Transects	Mean Linear Density	Confidence Level	LCB	UCB
3–3	Area 3 South	22	11.6	99	6.6	20.3
				95	7.6	17.8
				90	8.1	16.6
				75	9.2	15.1
3–4 & 5*	Area 3/4 Mainland	23	15.8	99	9.0	23.4
				95	10.3	22.3
				90	11.1	20.9
				75	12.4	19.2
3–6	Area 3 South	79	9.4	99	7.2	13.6
				95	7.6	12.8
				90	7.8	12.1
				75	8.2	11.2
3–7	Area 3 South	63	9.4	99	6.7	14.2
				95	7.3	12.6
				90	7.6	12.0
				75	8.1	11.2
3–8	Area 3 South	22	11.3	99	6.2	27.1
				95	7.2	20.7
				90	7.6	18.1
				75	8.7	15.4
3–9	Area 3 South	16	10.4	99	5.5	18.5
				95	6.2	16.0
				90	6.8	14.8
				75	7.7	13.5
3–10	Area 3 South	33	4.6	99	2.7	7.6
				95	3.0	6.8
				90	3.2	6.4
				75	3.7	5.9
4–5, 6†	Area 3/4 Mainland	22	20.6	99	12.3	33.3
				95	14.1	29.4
				90	15.2	27.7
				75	16.6	25.5
4–9	Area 3/4 Mainland	36	11.7	99	7.9	19.5
				95	8.5	17.4
				90	9.0	16.6
				75	9.7	14.7
4–14†	Area 3/4 Mainland	22	20.6	99	12.3	33.3
				95	14.1	29.4
				90	15.2	27.7
				75	16.6	25.5

Table 2, cont'd.

PFMA Subarea	Survey	No. Transects	Mean Linear Density	Confidence Level	LCB	UCB
7–7	Area 7 Mathieson	31	7.8	99	5.1	11.0
				95	5.8	10.2
				90	6.0	9.8
				75	6.5	9.2
7–9	Area 7 Mathieson	111	11.2	99	8.8	13.6
				95	9.5	13.2
				90	9.7	12.9
				75	10.1	12.3
7–10	Area 7 Mathieson	29	13.0	99	9.6	18.0
				95	10.3	16.6
				90	10.8	16.1
				75	11.6	15.2
7–11	Area 7 Mathieson	23	7.1	99	4.9	10.0
				95	5.4	9.3
				90	5.7	9.0
				75	6.0	8.4
7–24	Area 7–24	26	12.0	99	8.3	16.4
				95	9.2	15.3
				90	9.7	14.8
				75	10.4	13.8
7–29	Area 7 Mathieson	27	14.8	99	9.8	21.9
				95	11.0	20.3
				90	11.6	19.3
				75	12.3	17.9
17–3	Area 17	11	5.7	99	1.4	24.3
				95	2.0	18.7
				90	2.3	15.5
				75	3.0	11.9
17–4	Area 17	14	0.1	99	0.0	0.3
				95	0.0	0.2
				90	0.0	0.2
				75	0.0	0.1
17–5	Area 17	11	0.4	99	0.1	1.0
				95	0.1	0.9
				90	0.1	0.8
				75	0.2	0.6
17–18 & 21[‡]	Area 17	16	12.5	99	6.3	24.4
				95	7.5	21.3
				90	8.1	20.0
				75	9.2	17.1
17–19 & 20[**]	Area 17	9	2.1	99	0.1	4.8
				95	0.7	4.5
				90	0.7	4.1
				75	1.2	3.5

Table 3. Estimated mean weight of *Parastichopus californicus* from samples collected during June 2009 – May 2010. Data for Subarea 7–14 were collected from permanent BioTransects. The Subarea mean weight estimate is the mean of the transect averages, and is used for biomass calculations (Duprey et al. 2010).

PFMA Subarea	Survey	Transect no.	Mean weight by Transect (g)	SD	Mean weight by Subarea (g)
3-3	Area 3 South	234	293.2	67.50	290
3-3	Area 3 South	240	285.8	45.05	
3-4	Area 3/4 Mainland	79	330.6	61.16	281
3-4	Area 3/4 Mainland	87	230.9	47.94	
3-6	Area 3 South	14	126.0	52.22	176
3-6	Area 3 South	22	200.7	69.70	
3-6	Area 3 South	39	246.8	60.64	
3-6	Area 3 South	45	114.3	37.56	
3-6	Area 3 South	55	217.4	51.72	
3-6	Area 3 South	64	134.0	44.33	
3-6	Area 3 South	76	192.3	38.85	
3-7	Area 3 South	161	184.8	60.97	212
3-7	Area 3 South	175	330.1	79.16	
3-7	Area 3 South	182	183.4	46.73	
3-7	Area 3 South	193	182.4	43.64	
3-7	Area 3 South	201	199.5	49.52	
3-7	Area 3 South	217	191.0	34.61	
3-8	Area 3 South	132	242.5	54.52	245
3-8	Area 3 South	137	247.6	39.58	
3-9	Area 3 South	140	262.2	54.41	229
3-9	Area 3 South	145	198.0	36.94	
3-9	Area 3 South	150	226.1	48.50	
3-10	Area 3 South	92	206.5	46.24	249
3-10	Area 3 South	102	343.9	75.69	
3-10	Area 3 South	111	196.7	81.67	
4-5	Area 3/4 Mainland	45	363.5	68.93	319
4-5	Area 3/4 Mainland	68	274.6	75.69	
4-9	Area 3/4 Mainland	2	319.5	53.70	269
4-9	Area 3/4 Mainland	16	318.2	58.98	
4-9	Area 3/4 Mainland	26	245.1	58.19	
4-9	Area 3/4 Mainland	31	192.6	51.69	

Table 3, cont'd.

PFMA Subarea	Survey	Transect no.	Mean weight by Transect (g)	SD	Mean weight by Subarea (g)
7-7	Area 7 Mathieson	192	186.4	53.29	206
7-7	Area 7 Mathieson	202	175.6	73.69	
7-7	Area 7 Mathieson	211	255.4	94.56	
7-9	Area 7 Mathieson	8	198.6	62.57	251
7-9	Area 7 Mathieson	15	333.2	116.36	
7-9	Area 7 Mathieson	21	378.9	71.96	
7-9	Area 7 Mathieson	38	280.4	73.81	
7-9	Area 7 Mathieson	52	238.1	109.07	
7-9	Area 7 Mathieson	61	218.0	46.86	
7-9	Area 7 Mathieson	69	190.3	65.71	
7-9	Area 7 Mathieson	75	270.7	77.99	
7-9	Area 7 Mathieson	87	212.1	55.68	
7-9	Area 7 Mathieson	96	205.2	59.16	
7-9	Area 7 Mathieson	104	231.4	66.97	
7-9	Area 7 Mathieson	115	249.9	82.55	
7-10	Area 7 Mathieson	139	206.4	65.36	177
7-10	Area 7 Mathieson	145	147.3	50.99	
7-11	Area 7 Mathieson	156	311.4	47.32	255
7-11	Area 7 Mathieson	161	199.4	61.70	
7-14	Permanent BioTransects	2	196.7	41.01	272
7-14	Permanent BioTransects	41	260.0	53.02	
7-14	Permanent BioTransects	70	449.5	71.42	
7-14	Permanent BioTransects	76	233.4	48.33	
7-14	Permanent BioTransects	82	240.2	62.96	
7-14	Permanent BioTransects	88	319.1	64.87	
7-14	Permanent BioTransects	94	192.0	---	
7-14	Permanent BioTransects	114	231.9	51.71	
7-14	Permanent BioTransects	116	329.6	110.50	
7-24	Area 7–24	6	300.0	68.47	277
7-24	Area 7–24	10	264.6	61.40	
7-24	Area 7–24	23	267.6	107.41	
7-29	Area 7 Mathieson	216	143.3	43.03	170
7-29	Area 7 Mathieson	226	167.4	53.61	
7-29	Area 7 Mathieson	239	200.3	51.85	
17-3	Area 17	30	290.9	80.67	291
17-18	Area 17	53	233.8	55.04	234
17-21	Area 17	39	218.3	49.47	218

Table 4. Biomass estimates from Open Surveys conducted June 2009 – May 2010. Biosamples were not collected from all Subareas; the lowest Wt_{mean} in the same survey was used as Wt_{mean} for these Subareas (Duprey et al. 2011). Each PFMA Subarea was analyzed separately except those shown with *, **, †, or ‡ which indicates that the transects were pooled into for density analysis.

PFMA Subarea	Survey	Shoreline Length - protected (m)	Shoreline Length - exposed (m)	Confidence Level	Biomass (kg) LCB	Biomass (kg) UCB
3–3	Area 3 South	42,588	0	99	81,513	250,716
				95	93,864	219,839
				90	100,039	205,019
				75	113,625	186,493
3–4*	Area 3/4 Mainland	41,261	0	99	104,349	271,308
				95	119,422	258,554
				90	128,697	238,843
				75	143,770	222,611
3–5*	Area 3/4 Mainland	4099	0	99	9,924	25,802
				95	11,357	24,589
				90	12,239	23,045
				75	13,673	21,171
3–6	Area 3 South	156,608	3,596	99	200,036	376,439
				95	211,061	354,389
				90	216,574	335,095
				75	227,599	310,288
3–7	Area 3 South	109,922	0	99	156,133	330,909
				95	170,115	293,624
				90	177,106	279,642
				75	188,758	260,999
3–8	Area 3 South	46,150	0	99	70,102	306,413
				95	81,409	234,050
				90	85,931	204,652
				75	98,369	174,124
3–9	Area 3 South	23,386	0	99	29,455	99,075
				95	33,203	85,686
				90	36,417	79,260
				75	41,237	72,298
3–10	Area 3 South	67,822	0	99	45,597	128,346
				95	50,663	114,836
				90	54,041	108,081
				75	62,484	99,637
4–5†	Area 3/4 Mainland	106,871	83	99	419,396	1,135,325
				95	480,761	1,002,367
				90	518,262	944,410
				75	565,991	869,408

Table 4, cont'd.

PFMA Subarea	Survey	Shoreline Length - protected (m)	Shoreline Length - exposed (m)	Confidence Level	Biomass (kg) LCB	Biomass (kg) UCB
4–6†	Area 3/4 Mainland	4,519	0	99	14,952	40,480
				95	17,140	35,739
				90	18,477	33,672
				75	20,179	30,998
4–9	Area 3/4 Mainland	48,824	959	99	104,401	256,751
				95	112,281	229,171
				90	118,848	218,664
				75	128,041	193,710
4–14†	Area 3/4 Mainland	3,108	0	99	10,283	27,841
				95	11,788	24,580
				90	12,708	23,159
				75	13,878	21,319
7–7	Area 7 Mathieson	54,314	0	99	57,062	123,076
				95	64,894	114,125
				90	67,132	109,649
				75	72,726	102,936
7–9	Area 7 Mathieson	198,749	113	99	438,993	678,389
				95	473,905	658,439
				90	483,880	643,477
				75	503,829	613,552
7–10	Area 7 Mathieson	46,721	0	99	79,388	148,853
				95	85,177	137,276
				90	89,312	133,141
				75	95,928	125,698
7–11	Area 7 Mathieson	56,851	0	99	71,035	144,970
				95	78,284	134,822
				90	82,633	130,473
				75	86,982	121,775
7–24	Area 7–24	40,858	0	99	93,937	185,610
				95	104,123	173,160
				90	109,781	167,501
				75	117,704	156,184
7–29	Area 7 Mathieson	43,898	0	99	73,134	163,432
				95	82,089	151,492
				90	86,567	144,029
				75	91,791	133,582

Table 4, cont'd.

PFMA Subarea	Survey	Shoreline Length - protected (m)	Shoreline Length - exposed (m)	Confidence Level	Biomass (kg) LCB	Biomass (kg) UCB
17–3	Area 17	19,471	0	99	7,932	137,685
				95	11,332	105,955
				90	13,032	87,824
				75	16,998	67,426
17–4	Area 17	30,962	0	99	0	2,025
				95	0	1,350
				90	0	1,350
				75	0	675
17–5	Area 17	23,906	0	99	521	5,212
				95	521	4,690
				90	521	4,169
				75	1,042	3,127
17–18‡	Area 17	29,770	2,099	99	45,115	171,203
				95	53,474	149,608
				90	57,654	140,552
				75	65,317	120,350
17–19**	Area 17	5,042	2,585	99	1,519	6,685
				95	2,178	6,355
				90	2,178	5,915
				75	2,728	5,256
17–20**	Area 17	6,206	1,690	99	1,056	7,415
				95	1,868	7,009
				90	1,868	6,468
				75	2,545	5,656
17–21‡	Area 17	2,722	0	99	3,738	14,479
				95	4,450	12,639
				90	4,807	11,868
				75	5,459	10,147

Table 5. Linear density (sea cucumbers per meter shoreline) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Area 3 South survey.

				Linear density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Area 3 South	3	3	222	9.75	—	—
Area 3 South	3	3	223	6.50	—	—
Area 3 South	3	3	224	6.25	—	—
Area 3 South	3	3	225	8.75	—	—
Area 3 South	3	3	226	0.00	—	—
Area 3 South	3	3	227	38.00	—	—
Area 3 South	3	3	228	26.00	—	—
Area 3 South	3	3	229	25.00	—	—
Area 3 South	3	3	230	24.50	—	—
Area 3 South	3	3	231	8.75	—	—
Area 3 South	3	3	232	6.25	—	—
Area 3 South	3	3	233	0.00	0.0	0.0
Area 3 South	3	3	234	2.50	5.0	0.0
Area 3 South	3	3	235	3.00	17.5	0.0
Area 3 South	3	3	236	3.50	—	—
Area 3 South	3	3	237	5.00	16.5	0.5
Area 3 South	3	3	238	40.00	0.0	0.0
Area 3 South	3	3	239	1.00	5.0	0.0
Area 3 South	3	3	240	10.00	41.5	0.0
Area 3 South	3	3	241	0.00	2.0	0.0
Area 3 South	3	3	242	28.75	19.5	0.0
Area 3 South	3	3	243	1.25	36.5	3.5
Area 3 South	3	6	1	15.00	8.5	1.0
Area 3 South	3	6	2	59.75	5.0	0.0
Area 3 South	3	6	3	52.50	14.5	9.0
Area 3 South	3	6	4	16.75	16.5	5.5
Area 3 South	3	6	5	27.75	10.0	7.5
Area 3 South	3	6	6	3.50	5.5	2.5
Area 3 South	3	6	7	11.75	3.5	0.5
Area 3 South	3	6	8	11.25	8.0	13.5
Area 3 South	3	6	9	12.75	24.5	21.5
Area 3 South	3	6	10	41.00	25.5	42.0
Area 3 South	3	6	11	16.75	0.0	0.0
Area 3 South	3	6	12	6.75	16.0	30.0
Area 3 South	3	6	13	12.25	3.0	2.0
Area 3 South	3	6	14	6.50	0.5	0.5
Area 3 South	3	6	15	19.00	0.0	0.0
Area 3 South	3	6	16	10.00	0.0	0.0
Area 3 South	3	6	17	8.75	6.0	10.0
Area 3 South	3	6	18	6.50	0.0	0.0
Area 3 South	3	6	19	9.75	1.0	0.0
Area 3 South	3	6	20	8.50	0.0	0.0
Area 3 South	3	6	21	7.00	0.5	0.0
Area 3 South	3	6	22	9.00	0.0	0.0
Area 3 South	3	6	23	14.50	0.5	2.0
Area 3 South	3	6	24	6.00	0.0	0.0
Area 3 South	3	6	25	27.25	0.0	0.0
Area 3 South	3	6	26	13.00	0.0	0.0
Area 3 South	3	6	27	1.25	0.0	0.0
Area 3 South	3	6	28	4.25	0.0	13.0
Area 3 South	3	6	29	3.00	0.0	0.0
Area 3 South	3	6	30	1.00	0.0	0.0
Area 3 South	3	6	31	1.50	0.0	0.0
Area 3 South	3	6	32	4.00	0.0	6.0
Area 3 South	3	6	33	2.00	0.0	0.0
Area 3 South	3	6	34	6.50	0.0	8.5
Area 3 South	3	6	35	2.75	0.5	2.5
Area 3 South	3	6	36	3.50	0.0	0.0
Area 3 South	3	6	37	2.25	0.0	0.0
Area 3 South	3	6	38	1.25	0.0	0.0
Area 3 South	3	6	39	3.50	0.0	0.0
Area 3 South	3	6	40	10.25	1.5	4.5
Area 3 South	3	6	41	5.50	0.0	0.0
Area 3 South	3	6	42	0.75	0.0	0.0
Area 3 South	3	6	43	10.75	0.0	0.0
Area 3 South	3	6	44	0.00	0.0	0.0
Area 3 South	3	6	45	5.75	1.0	3.5
Area 3 South	3	6	46	1.25	0.0	0.0
Area 3 South	3	6	47	14.50	0.0	0.0
Area 3 South	3	6	48	11.00	0.0	0.0
Area 3 South	3	6	49	0.00	0.0	0.0
Area 3 South	3	6	50	0.00	0.5	0.0

Table 5, Area 3 South, cont'd.

				Linear density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Area 3 South	3	6	52	0.00	0.0	0.0
Area 3 South	3	6	53	3.00	0.0	0.0
Area 3 South	3	6	54	9.00	0.5	0.0
Area 3 South	3	6	55	2.75	0.0	0.0
Area 3 South	3	6	56	0.25	0.0	0.0
Area 3 South	3	6	57	6.00	0.0	0.5
Area 3 South	3	6	58	0.25	0.0	0.0
Area 3 South	3	6	59	2.00	0.0	1.5
Area 3 South	3	6	60	6.25	0.0	0.5
Area 3 South	3	6	61	5.75	0.0	0.0
Area 3 South	3	6	62	0.50	0.0	0.0
Area 3 South	3	6	63	5.50	0.0	0.0
Area 3 South	3	6	64	7.75	0.0	0.0
Area 3 South	3	6	65	7.75	2.0	2.5
Area 3 South	3	6	66	7.00	0.0	0.0
Area 3 South	3	6	67	12.50	5.5	1.5
Area 3 South	3	6	68	5.50	0.0	0.5
Area 3 South	3	6	69	6.75	5.5	0.5
Area 3 South	3	6	70	6.25	1.5	0.0
Area 3 South	3	6	71	6.50	0.0	0.0
Area 3 South	3	6	72	7.75	0.0	0.0
Area 3 South	3	6	73	14.25	0.0	0.0
Area 3 South	3	6	74	17.50	0.5	0.0
Area 3 South	3	6	75	8.00	5.0	2.0
Area 3 South	3	6	76	12.00	0.0	0.0
Area 3 South	3	6	77	12.75	6.0	0.0
Area 3 South	3	6	78	28.25	1.5	0.5
Area 3 South	3	6	79	2.25	1.5	0.0
Area 3 South	3	6	80	4.75	14.0	2.0
Area 3 South	3	7	156	27.25	52.5	24.5
Area 3 South	3	7	157	4.25	42.5	5.0
Area 3 South	3	7	160	15.00	56.0	0.0
Area 3 South	3	7	161	2.50	12.5	3.5
Area 3 South	3	7	162	1.50	5.5	4.5
Area 3 South	3	7	163	37.75	24.0	0.5
Area 3 South	3	7	164	0.25	0.0	0.0
Area 3 South	3	7	166	8.75	16.5	0.0
Area 3 South	3	7	167	1.25	5.5	1.0
Area 3 South	3	7	168	6.00	19.0	0.0
Area 3 South	3	7	169	0.75	9.0	0.0
Area 3 South	3	7	170	3.25	11.0	1.0
Area 3 South	3	7	171	23.75	44.0	0.0
Area 3 South	3	7	172	2.50	0.0	0.5
Area 3 South	3	7	173	10.25	0.0	0.0
Area 3 South	3	7	174	6.00	6.5	20.5
Area 3 South	3	7	175	1.25	0.0	0.0
Area 3 South	3	7	176	0.50	1.5	4.5
Area 3 South	3	7	177	12.25	2.0	1.5
Area 3 South	3	7	178	8.50	12.5	0.5
Area 3 South	3	7	179	14.25	18.5	0.0
Area 3 South	3	7	180	3.50	10.5	1.5
Area 3 South	3	7	181	1.50	0.0	0.0
Area 3 South	3	7	182	0.50	0.0	0.0
Area 3 South	3	7	183	33.50	19.0	0.0
Area 3 South	3	7	184	9.75	63.5	0.0
Area 3 South	3	7	185	7.75	4.0	0.0
Area 3 South	3	7	186	48.00	395.5	10.0
Area 3 South	3	7	187	8.75	218.0	0.0
Area 3 South	3	7	188	35.00	3.0	0.5
Area 3 South	3	7	189	21.25	3.0	0.0
Area 3 South	3	7	190	36.25	12.0	0.0
Area 3 South	3	7	191	5.75	0.0	0.0
Area 3 South	3	7	192	10.00	67.0	0.0
Area 3 South	3	7	193	6.75	149.5	0.0
Area 3 South	3	7	194	9.25	0.5	0.0
Area 3 South	3	7	195	19.50	17.5	0.0
Area 3 South	3	7	196	19.50	5.5	0.0
Area 3 South	3	7	197	7.00	2.0	1.5
Area 3 South	3	7	198	5.75	42.5	3.0
Area 3 South	3	7	199	3.00	14.5	4.5
Area 3 South	3	7	200	0.00	0.0	0.0
Area 3 South	3	7	201	5.25	4.0	0.0

Table 5 Area 3 South, cont'd.

				Linear density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallide*
Area 3 South	3	7	202	1.50	0.0	0.0
Area 3 South	3	7	203	2.75	0.0	0.0
Area 3 South	3	7	204	0.50	1.0	0.0
Area 3 South	3	7	205	3.25	1.0	0.0
Area 3 South	3	7	206	13.50	0.0	0.5
Area 3 South	3	7	207	5.50	0.0	0.0
Area 3 South	3	7	208	5.25	2.5	0.0
Area 3 South	3	7	209	4.75	6.0	14.5
Area 3 South	3	7	210	6.75	32.5	1.0
Area 3 South	3	7	211	12.00	34.5	7.5
Area 3 South	3	7	212	5.00	2.0	0.0
Area 3 South	3	7	213	12.25	0.5	0.0
Area 3 South	3	7	214	3.25	0.0	0.0
Area 3 South	3	7	215	3.00	0.0	0.0
Area 3 South	3	7	216	0.25	2.0	0.0
Area 3 South	3	7	217	2.50	11.0	0.0
Area 3 South	3	7	218	1.75	26.5	0.0
Area 3 South	3	7	219	0.00	2.0	0.0
Area 3 South	3	7	220	1.75	0.0	0.0
Area 3 South	3	7	221	21.50	95.5	0.0
Area 3 South	3	8	114	16.75	0.0	0.0
Area 3 South	3	8	115	18.25	2.5	0.0
Area 3 South	3	8	116	11.00	0.0	0.0
Area 3 South	3	8	117	30.75	0.0	0.0
Area 3 South	3	8	118	12.25	0.0	0.0
Area 3 South	3	8	119	6.00	46.0	57.5
Area 3 South	3	8	120	9.25	13.5	2.0
Area 3 South	3	8	121	12.75	0.0	0.0
Area 3 South	3	8	122	1.50	55.5	2.5
Area 3 South	3	8	123	0.00	0.0	0.0
Area 3 South	3	8	128	1.00	4.5	5.0
Area 3 South	3	8	129	0.25	0.0	0.0
Area 3 South	3	8	130	11.50	1.5	1.5
Area 3 South	3	8	131	0.00	0.0	0.0
Area 3 South	3	8	132	3.00	0.0	0.0
Area 3 South	3	8	133	5.00	0.0	0.0
Area 3 South	3	8	134	6.25	9.0	10.0
Area 3 South	3	8	135	12.00	0.5	0.0
Area 3 South	3	8	136	61.25	0.0	0.0
Area 3 South	3	8	137	4.00	0.0	0.0
Area 3 South	3	8	138	20.00	0.0	0.0
Area 3 South	3	8	139	6.75	5.0	0.5
Area 3 South	3	9	140	4.25	0.0	0.0
Area 3 South	3	9	141	0.00	0.0	0.0
Area 3 South	3	9	142	27.50	2.0	0.0
Area 3 South	3	9	143	7.25	—	—
Area 3 South	3	9	144	0.75	3.0	0.0
Area 3 South	3	9	145	8.00	2.0	2.0
Area 3 South	3	9	146	1.50	0.0	0.0
Area 3 South	3	9	147	5.75	0.5	4.0
Area 3 South	3	9	148	6.75	3.5	3.0
Area 3 South	3	9	149	2.50	0.0	0.0
Area 3 South	3	9	150	16.50	0.0	0.0
Area 3 South	3	9	151	9.75	0.0	0.5
Area 3 South	3	9	152	7.50	0.0	0.0
Area 3 South	3	9	153	31.50	35.0	4.5
Area 3 South	3	9	154	26.50	5.5	1.0
Area 3 South	3	9	155	5.75	0.0	0.0
Area 3 South	3	10	81	2.00	19.5	5.0
Area 3 South	3	10	82	0.00	0.0	0.0
Area 3 South	3	10	83	1.75	0.0	0.0
Area 3 South	3	10	84	0.50	0.0	0.0
Area 3 South	3	10	85	19.25	2.5	0.5
Area 3 South	3	10	86	11.50	0.0	0.0
Area 3 South	3	10	87	7.75	8.5	15.5
Area 3 South	3	10	88	0.75	0.0	0.0
Area 3 South	3	10	89	10.50	7.0	6.0
Area 3 South	3	10	90	7.25	0.0	1.0
Area 3 South	3	10	91	2.50	0.0	0.0
Area 3 South	3	10	92	5.00	0.0	4.0
Area 3 South	3	10	93	4.75	0.0	0.0
Area 3 South	3	10	94	0.00	0.0	0.0

Table 5 Area 3 South, cont'd.

Survey	PFMA	Subarea	Transect No.	Linear density (sc/m-sh)		
				P. californicus	*C. miniata*	*C. pallida*
Area 3 South	3	10	95	0.00	0.0	0.0
Area 3 South	3	10	96	0.00	0.0	0.0
Area 3 South	3	10	97	1.25	0.0	0.0
Area 3 South	3	10	98	0.50	0.0	0.0
Area 3 South	3	10	99	0.00	0.0	0.0
Area 3 South	3	10	100	3.75	0.0	0.0
Area 3 South	3	10	101	0.00	0.0	0.0
Area 3 South	3	10	102	0.75	0.0	0.0
Area 3 South	3	10	103	2.25	0.0	4.5
Area 3 South	3	10	104	0.00	0.0	0.0
Area 3 South	3	10	105	8.25	0.0	0.0
Area 3 South	3	10	106	2.75	0.5	0.5
Area 3 South	3	10	107	13.75	0.0	0.0
Area 3 South	3	10	108	17.25	0.0	0.0
Area 3 South	3	10	109	16.25	0.5	0.0
Area 3 South	3	10	110	0.00	0.0	1.5
Area 3 South	3	10	111	1.75	0.0	0.0
Area 3 South	3	10	112	2.75	0.0	6.5
Area 3 South	3	10	113	7.75	6.0	0.0

Table 6. Linear density (sea cucumbers / meter shoreline) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Area 3/4 Mainland survey.

				Linear density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
A3/4 Mainland	3	4	63	14.50	52.5	1.0
A3/4 Mainland	3	4	69	30.50	96.0	0.0
A3/4 Mainland	3	4	70	9.25	6.0	0.0
A3/4 Mainland	3	4	71	21.75	53.5	1.5
A3/4 Mainland	3	4	72	25.00	13.5	0.5
A3/4 Mainland	3	4	73	2.50	3.5	0.0
A3/4 Mainland	3	4	74	10.00	0.0	0.0
A3/4 Mainland	3	4	75	25.25	2.0	0.0
A3/4 Mainland	3	4	76	45.75	60.5	1.0
A3/4 Mainland	3	4	77	31.25	20.5	0.0
A3/4 Mainland	3	4	78	51.75	48.0	2.0
A3/4 Mainland	3	4	79	12.50	4.5	0.0
A3/4 Mainland	3	4	80	2.50	0.0	0.0
A3/4 Mainland	3	4	82	1.50	0.0	0.0
A3/4 Mainland	3	4	83	22.50	0.0	0.0
A3/4 Mainland	3	4	84	2.25	0.0	0.0
A3/4 Mainland	3	4	85	13.25	16.0	0.0
A3/4 Mainland	3	4	86	1.75	0.0	3.5
A3/4 Mainland	3	4	87	15.75	0.0	0.0
A3/4 Mainland	3	4	88	16.75	5.5	0.0
A3/4 Mainland	3	4	89	5.25	0.0	0.0
A3/4 Mainland	3	4	90	1.75	13.0	0.5
A3/4 Mainland	3	5	81	0.00	0.0	0.0
A3/4 Mainland	4	5	37	12.25	141.5	0.0
A3/4 Mainland	4	5	38	0.00	0.5	0.0
A3/4 Mainland	4	5	39	8.50	70.5	0.0
A3/4 Mainland	4	5	40	20.25	2.0	0.0
A3/4 Mainland	4	5	41	56.50	98.0	0.0
A3/4 Mainland	4	5	42	7.00	3.5	0.0
A3/4 Mainland	4	5	43	22.75	18.0	0.0
A3/4 Mainland	4	5	44	0.25	0.0	0.0
A3/4 Mainland	4	5	45	26.75	10.5	0.0
A3/4 Mainland	4	5	46	22.50	0.0	0.0
A3/4 Mainland	4	5	47	2.00	0.0	0.0
A3/4 Mainland	4	5	57	22.75	29.0	0.0
A3/4 Mainland	4	5	58	29.25	59.5	0.0
A3/4 Mainland	4	5	64	23.75	49.5	8.0
A3/4 Mainland	4	5	65	51.50	32.5	4.5
A3/4 Mainland	4	5	66	16.50	0.0	0.0
A3/4 Mainland	4	5	67	20.25	166.0	6.0
A3/4 Mainland	4	5	68	14.50	19.0	0.0
A3/4 Mainland	4	6	60	0.00	0.0	0.0
A3/4 Mainland	4	6	62	64.25	22.0	0.0
A3/4 Mainland	4	7	53	1.50	0.5	0.0
A3/4 Mainland	4	7	54	0.00	0.0	0.0
A3/4 Mainland	4	7	55	23.75	0.5	0.0
A3/4 Mainland	4	8	48	0.00	0.0	0.0
A3/4 Mainland	4	8	49	0.00	17.5	0.0
A3/4 Mainland	4	8	50	0.00	0.0	0.0
A3/4 Mainland	4	8	51	0.00	1.5	0.0
A3/4 Mainland	4	8	52	0.00	5.0	0.0
A3/4 Mainland	4	9	1	1.50	—	—
A3/4 Mainland	4	9	2	3.00	—	—
A3/4 Mainland	4	9	3	2.25	—	—
A3/4 Mainland	4	9	4	7.25	37.0	2.0
A3/4 Mainland	4	9	5	0.75	6.5	1.0
A3/4 Mainland	4	9	6	16.25	0.0	0.0
A3/4 Mainland	4	9	7	1.75	0.0	0.0
A3/4 Mainland	4	9	8	40.75	2.5	0.5
A3/4 Mainland	4	9	9	7.75	0.5	0.0
A3/4 Mainland	4	9	10	11.75	4.0	0.5
A3/4 Mainland	4	9	11	22.00	4.0	0.5
A3/4 Mainland	4	9	12	0.50	0.0	0.0
A3/4 Mainland	4	9	13	11.25	13.0	0.0
A3/4 Mainland	4	9	14	16.75	2.0	0.0
A3/4 Mainland	4	9	15	10.25	11.0	2.5
A3/4 Mainland	4	9	16	12.25	29.0	0.0
A3/4 Mainland	4	9	17	9.25	—	—
A3/4 Mainland	4	9	18	12.50	—	—
A3/4 Mainland	4	9	19	3.00	59.5	0.0
A3/4 Mainland	4	9	20	22.50	0.5	0.0
A3/4 Mainland	4	9	21	2.50	—	—

Table 6, Area 3/4 Mainland survey cont'd.

				Linear density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
A3/4 Mainland	4	9	22	20.00	---	—
A3/4 Mainland	4	9	23	35.50	49.0	0.0
A3/4 Mainland	4	9	24	6.25	—	—
A3/4 Mainland	4	9	25	17.25	—	—
A3/4 Mainland	4	9	26	29.25	—	—
A3/4 Mainland	4	9	27	0.00	0.0	0.0
A3/4 Mainland	4	9	28	9.50	10.5	0.0
A3/4 Mainland	4	9	29	0.00	0.0	0.0
A3/4 Mainland	4	9	30	13.00	2.0	0.0
A3/4 Mainland	4	9	31	4.25	26.5	0.0
A3/4 Mainland	4	9	32	0.00	0.0	0.0
A3/4 Mainland	4	9	33	0.25	0.0	0.0
A3/4 Mainland	4	9	34	5.75	2.0	0.0
A3/4 Mainland	4	9	35	5.75	9.0	0.0
A3/4 Mainland	4	9	36	60.25	64.5	0.5
A3/4 Mainland	4	14	59	8.50	6.0	0.0
A3/4 Mainland	4	14	61	23.25	2.0	0.0

Table 7. Linear density (sea cucumbers / meter shoreline) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Area 7 Mathieson survey.

				Linear Density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Area 7 Mathieson	7	7	184	0.75	1.5	0.0
Area 7 Mathieson	7	7	185	11.50	4.5	38.0
Area 7 Mathieson	7	7	186	14.00	24.0	19.5
Area 7 Mathieson	7	7	187	9.00	0.0	0.0
Area 7 Mathieson	7	7	188	16.75	42.0	82.5
Area 7 Mathieson	7	7	189	8.75	42.0	97.5
Area 7 Mathieson	7	7	190	2.50	7.5	33.0
Area 7 Mathieson	7	7	191	3.75	0.0	0.0
Area 7 Mathieson	7	7	192	19.25	62.5	66.0
Area 7 Mathieson	7	7	194	17.50	37.5	2.5
Area 7 Mathieson	7	7	195	8.50	1.0	0.0
Area 7 Mathieson	7	7	196	10.50	0.0	0.0
Area 7 Mathieson	7	7	197	6.00	0.0	1.5
Area 7 Mathieson	7	7	198	17.75	15.0	12.0
Area 7 Mathieson	7	7	199	23.50	55.0	17.5
Area 7 Mathieson	7	7	200	11.00	76.0	51.5
Area 7 Mathieson	7	7	201	11.75	13.0	31.5
Area 7 Mathieson	7	7	202	2.50	0.5	10.0
Area 7 Mathieson	7	7	203	0.50	2.5	0.0
Area 7 Mathieson	7	7	204	0.00	0.0	0.0
Area 7 Mathieson	7	7	205	0.00	0.0	0.0
Area 7 Mathieson	7	7	206	1.50	0.0	0.0
Area 7 Mathieson	7	7	207	9.25	0.0	1.0
Area 7 Mathieson	7	7	208	2.50	0.0	0.0
Area 7 Mathieson	7	7	209	4.50	0.0	0.0
Area 7 Mathieson	7	7	210	0.25	0.0	0.0
Area 7 Mathieson	7	7	211	2.25	0.5	0.0
Area 7 Mathieson	7	7	212	6.00	1.5	0.0
Area 7 Mathieson	7	7	213	3.50	0.0	4.0
Area 7 Mathieson	7	7	214	2.25	2.5	4.0
Area 7 Mathieson	7	7	215	13.75	4.0	1.5
Area 7 Mathieson	7	9	1	1.75	7.0	14.0
Area 7 Mathieson	7	9	2	3.75	12.5	2.0
Area 7 Mathieson	7	9	3	4.25	0.5	0.5
Area 7 Mathieson	7	9	4	0.75	1.0	0.0
Area 7 Mathieson	7	9	5	9.50	72.5	2.5
Area 7 Mathieson	7	9	6	1.00	4.0	1.0
Area 7 Mathieson	7	9	7	0.00	0.0	0.0
Area 7 Mathieson	7	9	8	1.50	19.0	8.0
Area 7 Mathieson	7	9	9	13.25	27.0	45.5
Area 7 Mathieson	7	9	11	0.75	14.5	28.0
Area 7 Mathieson	7	9	12	0.25	7.0	1.5
Area 7 Mathieson	7	9	13	0.00	2.0	6.0
Area 7 Mathieson	7	9	14	9.25	0.0	125.5
Area 7 Mathieson	7	9	15	5.25	7.5	8.0
Area 7 Mathieson	7	9	16	0.00	0.5	0.0
Area 7 Mathieson	7	9	17	0.00	0.0	0.0
Area 7 Mathieson	7	9	18	7.25	0.0	0.0
Area 7 Mathieson	7	9	19	2.25	0.0	0.0
Area 7 Mathieson	7	9	20	10.75	59.0	90.0
Area 7 Mathieson	7	9	21	22.50	13.0	0.0
Area 7 Mathieson	7	9	22	6.50	76.5	8.5
Area 7 Mathieson	7	9	23	0.00	10.5	1.5
Area 7 Mathieson	7	9	24	26.75	10.0	0.0
Area 7 Mathieson	7	9	25	2.50	0.5	0.0
Area 7 Mathieson	7	9	26	9.50	44.0	18.0
Area 7 Mathieson	7	9	27	4.25	85.0	25.5
Area 7 Mathieson	7	9	28	19.50	56.0	32.5
Area 7 Mathieson	7	9	29	6.00	14.5	20.5
Area 7 Mathieson	7	9	30	0.00	0.0	0.0
Area 7 Mathieson	7	9	31	0.25	0.0	0.0
Area 7 Mathieson	7	9	32	5.25	0.0	0.0
Area 7 Mathieson	7	9	33	13.25	1.5	0.0
Area 7 Mathieson	7	9	34	8.50	2.5	0.0
Area 7 Mathieson	7	9	35	8.50	5.0	9.5
Area 7 Mathieson	7	9	36	3.25	25.0	47.5
Area 7 Mathieson	7	9	37	3.50	29.0	23.5
Area 7 Mathieson	7	9	38	14.00	17.5	1.5
Area 7 Mathieson	7	9	39	5.25	0.0	1.5
Area 7 Mathieson	7	9	40	8.25	11.0	47.5
Area 7 Mathieson	7	9	41	17.50	0.0	0.0
Area 7 Mathieson	7	9	42	11.25	2.0	0.5

Table 7, Mathieson survey cont'd.

				Linear Density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Area 7 Mathieson	7	9	43	23.50	5.5	0.0
Area 7 Mathieson	7	9	44	10.75	12.0	22.5
Area 7 Mathieson	7	9	45	7.00	0.0	5.5
Area 7 Mathieson	7	9	46	20.50	1.0	2.5
Area 7 Mathieson	7	9	47	9.50	1.0	1.5
Area 7 Mathieson	7	9	48	16.75	0.0	10.5
Area 7 Mathieson	7	9	49	10.50	1.5	3.5
Area 7 Mathieson	7	9	50	6.75	0.0	0.0
Area 7 Mathieson	7	9	51	15.75	1.0	8.0
Area 7 Mathieson	7	9	52	11.75	4.5	6.0
Area 7 Mathieson	7	9	53	13.25	11.0	87.0
Area 7 Mathieson	7	9	54	7.50	0.0	0.0
Area 7 Mathieson	7	9	55	18.25	6.5	9.5
Area 7 Mathieson	7	9	56	9.75	4.0	6.5
Area 7 Mathieson	7	9	57	42.00	12.5	25.0
Area 7 Mathieson	7	9	58	4.25	3.5	5.0
Area 7 Mathieson	7	9	59	6.75	14.5	9.5
Area 7 Mathieson	7	9	60	6.25	31.0	97.0
Area 7 Mathieson	7	9	61	2.50	11.0	2.5
Area 7 Mathieson	7	9	62	7.25	2.0	6.5
Area 7 Mathieson	7	9	63	6.50	1.5	0.0
Area 7 Mathieson	7	9	64	4.50	1.5	0.5
Area 7 Mathieson	7	9	65	7.75	0.5	1.0
Area 7 Mathieson	7	9	66	26.50	11.0	2.5
Area 7 Mathieson	7	9	67	10.25	0.0	0.0
Area 7 Mathieson	7	9	68	59.25	13.5	9.0
Area 7 Mathieson	7	9	69	17.50	3.0	14.0
Area 7 Mathieson	7	9	70	10.50	2.5	0.5
Area 7 Mathieson	7	9	71	35.25	27.0	119.5
Area 7 Mathieson	7	9	72	26.75	41.0	89.5
Area 7 Mathieson	7	9	73	3.75	0.0	4.0
Area 7 Mathieson	7	9	74	42.00	3.5	6.5
Area 7 Mathieson	7	9	75	12.50	14.0	0.0
Area 7 Mathieson	7	9	78	7.50	0.5	0.0
Area 7 Mathieson	7	9	79	8.50	7.5	26.0
Area 7 Mathieson	7	9	80	21.00	94.0	92.5
Area 7 Mathieson	7	9	81	14.25	1.0	7.0
Area 7 Mathieson	7	9	82	5.75	0.0	0.0
Area 7 Mathieson	7	9	83	5.50	2.0	8.0
Area 7 Mathieson	7	9	84	11.50	7.5	23.5
Area 7 Mathieson	7	9	85	12.25	22.0	134.0
Area 7 Mathieson	7	9	86	12.50	22.0	93.0
Area 7 Mathieson	7	9	87	27.00	3.0	0.0
Area 7 Mathieson	7	9	88	3.50	0.0	0.0
Area 7 Mathieson	7	9	89	12.75	5.5	10.5
Area 7 Mathieson	7	9	90	22.75	18.5	97.0
Area 7 Mathieson	7	9	91	0.25	2.5	0.0
Area 7 Mathieson	7	9	92	9.75	0.0	0.0
Area 7 Mathieson	7	9	93	3.75	0.0	0.0
Area 7 Mathieson	7	9	94	5.75	0.0	0.5
Area 7 Mathieson	7	9	95	3.00	0.0	0.0
Area 7 Mathieson	7	9	96	2.75	5.0	8.0
Area 7 Mathieson	7	9	97	10.25	7.5	4.0
Area 7 Mathieson	7	9	98	23.00	20.5	76.5
Area 7 Mathieson	7	9	99	23.50	0.0	25.5
Area 7 Mathieson	7	9	100	12.25	8.5	36.5
Area 7 Mathieson	7	9	101	8.25	1.5	26.5
Area 7 Mathieson	7	9	102	17.50	4.0	15.0
Area 7 Mathieson	7	9	103	24.00	4.5	215.0
Area 7 Mathieson	7	9	104	23.50	20.5	103.5
Area 7 Mathieson	7	9	112	5.50	1.5	0.0
Area 7 Mathieson	7	9	113	27.00	44.5	21.5
Area 7 Mathieson	7	9	114	27.25	28.0	9.0
Area 7 Mathieson	7	9	115	13.50	22.5	71.0
Area 7 Mathieson	7	9	116	10.25	52.0	40.5
Area 7 Mathieson	7	9	117	4.00	1.0	65.5
Area 7 Mathieson	7	9	127	3.75	0.0	0.0
Area 7 Mathieson	7	9	128	8.50	0.0	0.5
Area 7 Mathieson	7	9	129	13.00	31.0	89.5
Area 7 Mathieson	7	9	130	13.50	12.0	20.0
Area 7 Mathieson	7	10	131	19.50	27.5	50.0
Area 7 Mathieson	7	10	132	5.25	0.0	0.0

Table 7, Mathieson survey cont'd.

				Linear Density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Area 7 Mathieson	7	10	133	8.50	0.0	0.0
Area 7 Mathieson	7	10	134	26.00	23.0	58.5
Area 7 Mathieson	7	10	135	21.25	20.5	31.0
Area 7 Mathieson	7	10	136	16.25	8.5	63.0
Area 7 Mathieson	7	10	137	33.00	16.0	11.5
Area 7 Mathieson	7	10	138	19.00	12.5	46.5
Area 7 Mathieson	7	10	139	16.50	37.5	124.5
Area 7 Mathieson	7	10	140	1.50	2.0	4.5
Area 7 Mathieson	7	10	141	12.00	6.5	16.5
Area 7 Mathieson	7	10	142	5.50	1.5	0.5
Area 7 Mathieson	7	10	143	15.75	3.0	0.0
Area 7 Mathieson	7	10	144	4.25	0.0	0.0
Area 7 Mathieson	7	10	145	12.25	26.5	44.0
Area 7 Mathieson	7	10	146	9.50	0.0	0.0
Area 7 Mathieson	7	10	147	5.75	0.5	21.0
Area 7 Mathieson	7	10	148	3.25	6.5	61.5
Area 7 Mathieson	7	10	149	5.50	0.0	6.5
Area 7 Mathieson	7	10	150	8.75	1.5	49.0
Area 7 Mathieson	7	10	151	12.50	0.0	0.0
Area 7 Mathieson	7	10	152	16.50	21.0	148.5
Area 7 Mathieson	7	10	153	5.25	1.5	0.0
Area 7 Mathieson	7	10	154	13.75	8.5	59.0
Area 7 Mathieson	7	10	155	33.75	7.5	38.5
Area 7 Mathieson	7	10	156	7.75	0.5	0.0
Area 7 Mathieson	7	10	157	4.00	1.0	1.0
Area 7 Mathieson	7	10	158	20.00	1.0	42.0
Area 7 Mathieson	7	10	159	15.00	16.5	57.0
Area 7 Mathieson	7	11	160	8.50	0.0	0.0
Area 7 Mathieson	7	11	161	8.25	3.0	4.5
Area 7 Mathieson	7	11	162	8.75	29.5	72.0
Area 7 Mathieson	7	11	163	11.50	9.5	7.5
Area 7 Mathieson	7	11	164	12.00	0.5	0.5
Area 7 Mathieson	7	11	165	5.75	8.0	23.0
Area 7 Mathieson	7	11	166	6.00	0.0	0.0
Area 7 Mathieson	7	11	167	5.50	0.0	4.5
Area 7 Mathieson	7	11	168	3.50	0.0	0.0
Area 7 Mathieson	7	11	169	4.25	0.5	0.0
Area 7 Mathieson	7	11	171	16.25	18.0	0.5
Area 7 Mathieson	7	11	172	4.00	1.5	2.0
Area 7 Mathieson	7	11	173	9.75	3.5	7.0
Area 7 Mathieson	7	11	174	1.25	0.0	0.0
Area 7 Mathieson	7	11	175	13.75	1.5	2.5
Area 7 Mathieson	7	11	176	3.00	0.0	0.0
Area 7 Mathieson	7	11	177	0.50	0.5	0.0
Area 7 Mathieson	7	11	178	0.50	0.0	0.0
Area 7 Mathieson	7	11	179	6.75	1.5	4.0
Area 7 Mathieson	7	11	180	3.25	0.5	0.5
Area 7 Mathieson	7	11	181	3.50	1.0	1.0
Area 7 Mathieson	7	11	182	18.25	88.5	51.5
Area 7 Mathieson	7	11	183	9.50	38.0	164.0
Area 7 Mathieson	7	29	216	28.00	89.5	28.5
Area 7 Mathieson	7	29	217	8.50	0.5	0.0
Area 7 Mathieson	7	29	218	28.25	0.0	0.0
Area 7 Mathieson	7	29	219	8.25	2.0	33.0
Area 7 Mathieson	7	29	220	8.50	2.0	8.5
Area 7 Mathieson	7	29	221	25.75	56.5	48.0
Area 7 Mathieson	7	29	222	16.75	1.0	0.0
Area 7 Mathieson	7	29	223	4.25	2.5	0.0
Area 7 Mathieson	7	29	224	24.00	63.0	17.0
Area 7 Mathieson	7	29	225	1.50	0.0	0.0
Area 7 Mathieson	7	29	226	4.50	6.5	0.5
Area 7 Mathieson	7	29	227	5.75	4.0	1.0
Area 7 Mathieson	7	29	228	0.25	5.0	0.0
Area 7 Mathieson	7	29	229	11.00	9.0	4.5
Area 7 Mathieson	7	29	230	2.00	0.0	2.0
Area 7 Mathieson	7	29	231	11.25	17.0	39.5
Area 7 Mathieson	7	29	232	11.00	9.5	24.0
Area 7 Mathieson	7	29	233	12.75	1.0	0.0
Area 7 Mathieson	7	29	234	11.75	1.0	0.5
Area 7 Mathieson	7	29	235	16.75	59.0	64.5
Area 7 Mathieson	7	29	236	22.50	69.0	3.0
Area 7 Mathieson	7	29	237	16.75	21.0	38.0

Table 7, Mathieson survey cont'd.

Survey	PFMA	Subarea	Transect No.	Linear Density (sc/m-sh)		
				P. californicus	*C. miniata*	*C. pallida*
Area 7 Mathieson	7	29	238	10.75	0.0	1.5
Area 7 Mathieson	7	29	239	31.50	17.0	11.0
Area 7 Mathieson	7	29	240	10.50	3.5	2.5
Area 7 Mathieson	7	29	241	54.00	10.5	0.0
Area 7 Mathieson	7	29	242	13.00	0.0	7.0

Table 8. Linear density (sea cucumbers / meter shoreline) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Area 7–24 survey.

Survey	PFMA	Subarea	Transect No.	Linear density (sc/m-sh)		
				P. californicus	*C. miniata*	*C. pallida*
Area 7-24	7	24	1	1.25	4.5	15.5
Area 7-24	7	24	2	27.25	8.0	0.0
Area 7-24	7	24	3	10.50	18.5	1.5
Area 7-24	7	24	4	23.25	8.0	13.0
Area 7-24	7	24	5	0.00	0.0	0.0
Area 7-24	7	24	6	9.75	4.0	33.5
Area 7-24	7	24	7	13.25	1.0	8.0
Area 7-24	7	24	8	30.25	13.5	19.5
Area 7-24	7	24	9	9.25	38.5	16.0
Area 7-24	7	24	10	10.75	47.5	23.0
Area 7-24	7	24	11	8.25	6.0	1.0
Area 7-24	7	24	12	9.75	6.5	10.0
Area 7-24	7	24	13	3.25	0.0	2.0
Area 7-24	7	24	14	12.75	0.0	0.0
Area 7-24	7	24	15	13.25	0.0	14.0
Area 7-24	7	24	16	7.50	43.0	6.5
Area 7-24	7	24	17	16.50	23.0	18.5
Area 7-24	7	24	18	21.75	2.5	0.0
Area 7-24	7	24	19	14.00	0.0	0.0
Area 7-24	7	24	20	7.00	1.5	0.0
Area 7-24	7	24	21	25.50	5.0	8.5
Area 7-24	7	24	22	13.00	5.0	23.0
Area 7-24	7	24	23	11.00	2.5	3.5
Area 7-24	7	24	24	6.50	4.5	2.5
Area 7-24	7	24	25	2.50	2.0	1.0
Area 7-24	7	24	26	3.50	7.5	6.5

Table 9. Linear density (sea cucumbers / meter shoreline) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Area 17 survey.

				Linear density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Area 17	17	3	27	0.25	–	–
Area 17	17	3	28	2.50	–	–
Area 17	17	3	29	7.75	–	–
Area 17	17	3	30	8.00	–	–
Area 17	17	3	31	1.50	–	–
Area 17	17	3	32	0.50	–	–
Area 17	17	3	33	5.25	–	–
Area 17	17	3	34	37.00	–	–
Area 17	17	3	35	0.00	–	–
Area 17	17	3	36	0.00	–	–
Area 17	17	3	37	0.00	–	–
Area 17	17	4	1	0.00	–	–
Area 17	17	4	2	0.00	–	–
Area 17	17	4	3	0.00	–	–
Area 17	17	4	4	0.00	–	–
Area 17	17	4	5	0.00	–	–
Area 17	17	4	6	0.00	–	–
Area 17	17	4	7	0.25	–	–
Area 17	17	4	8	0.00	–	–
Area 17	17	4	9	0.00	–	–
Area 17	17	4	10	0.00	–	–
Area 17	17	4	11	0.75	–	–
Area 17	17	4	12	0.00	–	–
Area 17	17	4	13	0.00	–	–
Area 17	17	4	14	0.00	–	–
Area 17	17	5	15	0.25	–	–
Area 17	17	5	16	0.00	–	–
Area 17	17	5	17	0.00	–	–
Area 17	17	5	18	0.00	–	–
Area 17	17	5	20	1.75	–	–
Area 17	17	5	21	0.00	–	–
Area 17	17	5	22	0.00	–	–
Area 17	17	5	23	0.00	–	–
Area 17	17	5	24	1.50	–	–
Area 17	17	5	25	0.50	–	–
Area 17	17	5	26	0.25	–	–
Area 17	17	18	40	7.50	–	–
Area 17	17	18	41	14.00	–	–
Area 17	17	18	42	0.00	–	–
Area 17	17	18	43	0.00	–	–
Area 17	17	18	44	0.00	–	–
Area 17	17	18	45	3.50	–	–
Area 17	17	18	46	10.50	–	–
Area 17	17	18	47	7.50	–	–
Area 17	17	18	48	0.00	–	–
Area 17	17	18	49	24.25	–	–
Area 17	17	18	50	49.50	–	–
Area 17	17	18	51	16.00	–	–
Area 17	17	18	52	10.50	–	–
Area 17	17	18	53	16.50	–	–
Area 17	17	19	54	5.50	–	–
Area 17	17	19	55	7.00	–	–
Area 17	17	19	56	5.25	–	–
Area 17	17	19	62	0.00	–	–
Area 17	17	19	63	0.00	–	–
Area 17	17	20	58	0.50	–	–
Area 17	17	20	59	0.00	–	–
Area 17	17	20	60	0.00	–	–
Area 17	17	20	61	0.25	–	–
Area 17	17	21	38	7.75	–	–
Area 17	17	21	39	32.75	–	–

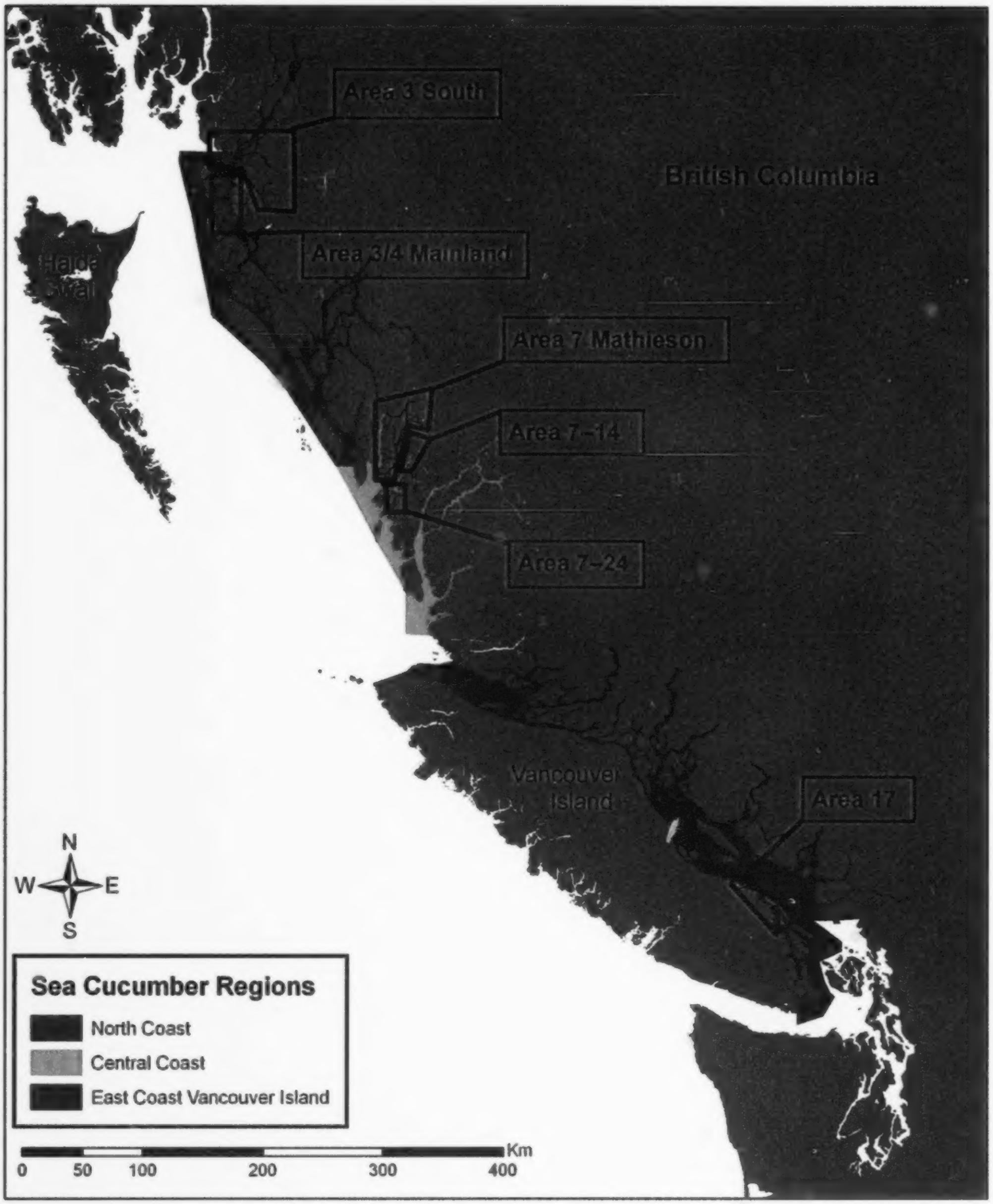

Area 3 South
British Columbia
Area 3/4 Mainland
Haida Gwaii
Area 7 Mathieson
Area 7-14
Area 7-24
Vancouver Island
Area 17
N
W
E
S
Sea Cucumber Regions
North Coast
Central Coast
East Coast Vancouver Island
Km
0
50
100
200
300
400

Figure 1. Sea cucumber surveys conducted June 2009 to May 2010. Open surveys were conducted in Area 3 South, Area 3/4 Mainland, Area 7 Mathieson, Area 7–24 and Area 17. A permanent BioTransect survey was conducted in Area 7–14.

Table 9. Linear density (sea cucumbers / meter shoreline) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Area 17 survey.

				Linear density (sc/m-sh)		
Survey	PFMA	Subarea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Area 17	17	3	27	0.25	–	–
Area 17	17	3	28	2.50	–	–
Area 17	17	3	29	7.75	–	–
Area 17	17	3	30	8.00	–	–
Area 17	17	3	31	1.50	–	–
Area 17	17	3	32	0.50	–	–
Area 17	17	3	33	5.25	–	–
Area 17	17	3	34	37.00	–	–
Area 17	17	3	35	0.00	–	–
Area 17	17	3	36	0.00	–	–
Area 17	17	3	37	0.00	–	–
Area 17	17	4	1	0.00	–	–
Area 17	17	4	2	0.00	–	–
Area 17	17	4	3	0.00	–	–
Area 17	17	4	4	0.00	–	–
Area 17	17	4	5	0.00	–	–
Area 17	17	4	6	0.00	–	–
Area 17	17	4	7	0.25	–	–
Area 17	17	4	8	0.00	–	–
Area 17	17	4	9	0.00	–	–
Area 17	17	4	10	0.00	–	–
Area 17	17	4	11	0.75	–	–
Area 17	17	4	12	0.00	–	–
Area 17	17	4	13	0.00	–	–
Area 17	17	4	14	0.00	–	–
Area 17	17	5	15	0.25	–	–
Area 17	17	5	16	0.00	–	–
Area 17	17	5	17	0.00	–	–
Area 17	17	5	18	0.00	–	–
Area 17	17	5	20	1.75	–	–
Area 17	17	5	21	0.00	–	–
Area 17	17	5	22	0.00	–	–
Area 17	17	5	23	0.00	–	–
Area 17	17	5	24	1.50	–	–
Area 17	17	5	25	0.50	–	–
Area 17	17	5	26	0.25	–	–
Area 17	17	18	40	7.50	–	–
Area 17	17	18	41	14.00	–	–
Area 17	17	18	42	0.00	–	–
Area 17	17	18	43	0.00	–	–
Area 17	17	18	44	0.00	–	–
Area 17	17	18	45	3.50	–	–
Area 17	17	18	46	10.50	–	–
Area 17	17	18	47	7.50	–	–
Area 17	17	18	48	0.00	–	–
Area 17	17	18	49	24.25	–	–
Area 17	17	18	50	49.50	–	–
Area 17	17	18	51	16.00	–	–
Area 17	17	18	52	10.50	–	–
Area 17	17	18	53	16.50	–	–
Area 17	17	19	54	5.50	–	–
Area 17	17	19	55	7.00	–	–
Area 17	17	19	56	5.25	–	–
Area 17	17	19	62	0.00	–	–
Area 17	17	19	63	0.00	–	–
Area 17	17	20	58	0.50	–	–
Area 17	17	20	59	0.00	–	–
Area 17	17	20	60	0.00	–	–
Area 17	17	20	61	0.25	–	–
Area 17	17	21	38	7.75	–	–
Area 17	17	21	39	32.75	–	–

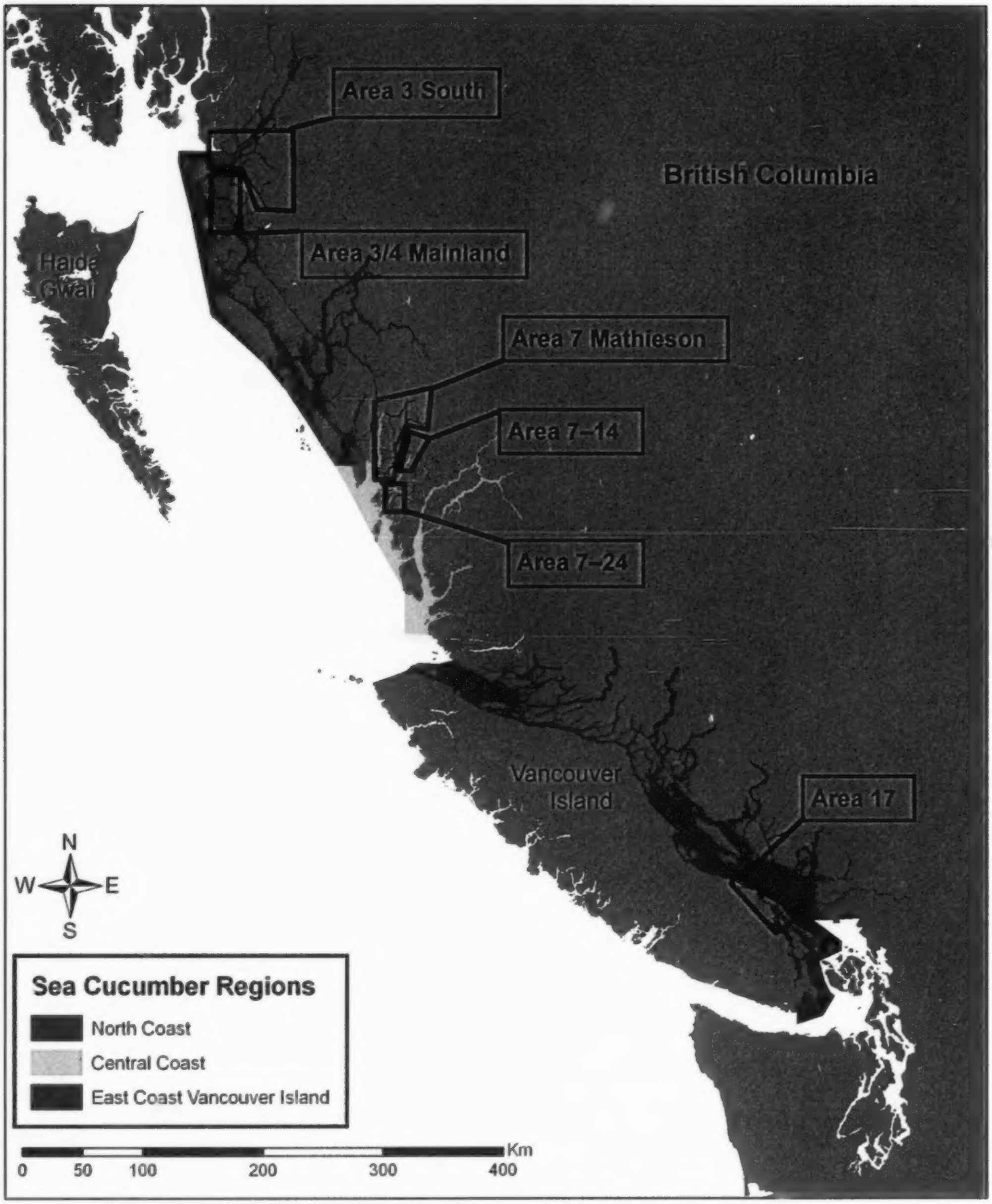

Area 3 South
British Columbia
Area 3/4 Mainland
Haida Gwaii
Area 7 Mathieson
Area 7–14
Area 7–24
Vancouver Island
Area 17
N
W
E
S
Sea Cucumber Regions
North Coast
Central Coast
East Coast Vancouver Island
0
50
100
200
300
400
Km

Figure 1. Sea cucumber surveys conducted June 2009 to May 2010. Open surveys were conducted in Area 3 South, Area 3/4 Mainland, Area 7 Mathieson, Area 7–24 and Area 17. A permanent BioTransect survey was conducted in Area 7–14.

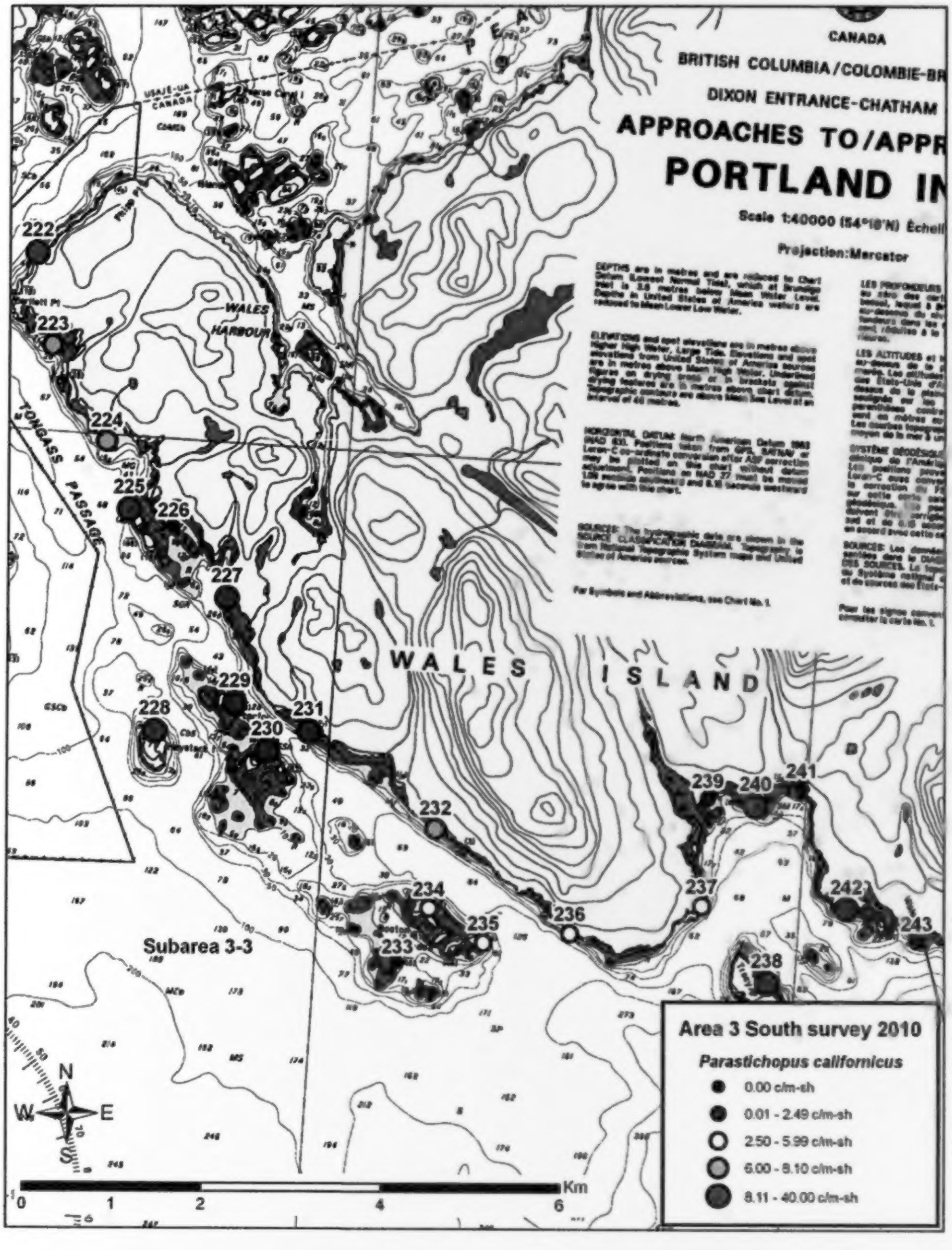

CANADA
BRITISH COLUMBIA/COLOMBIE-BR
DIXON ENTRANCE-CHATHAM
APPROACHES TO/APPR
PORTLAND IN
Scale 1:40000 (54°10'N) Échell
Projection: Mercator
WALES HARBOUR
TONGASS PASSAGE
WALES ISLAND
Subarea 3-3
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
N
E
S
W
0
1
2
4
6
Km
Area 3 South survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 8.10 c/m-sh
● 8.11 - 40.00 c/m-sh

Figure 2. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 3–3, surveyed as part of the Area 3 South survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

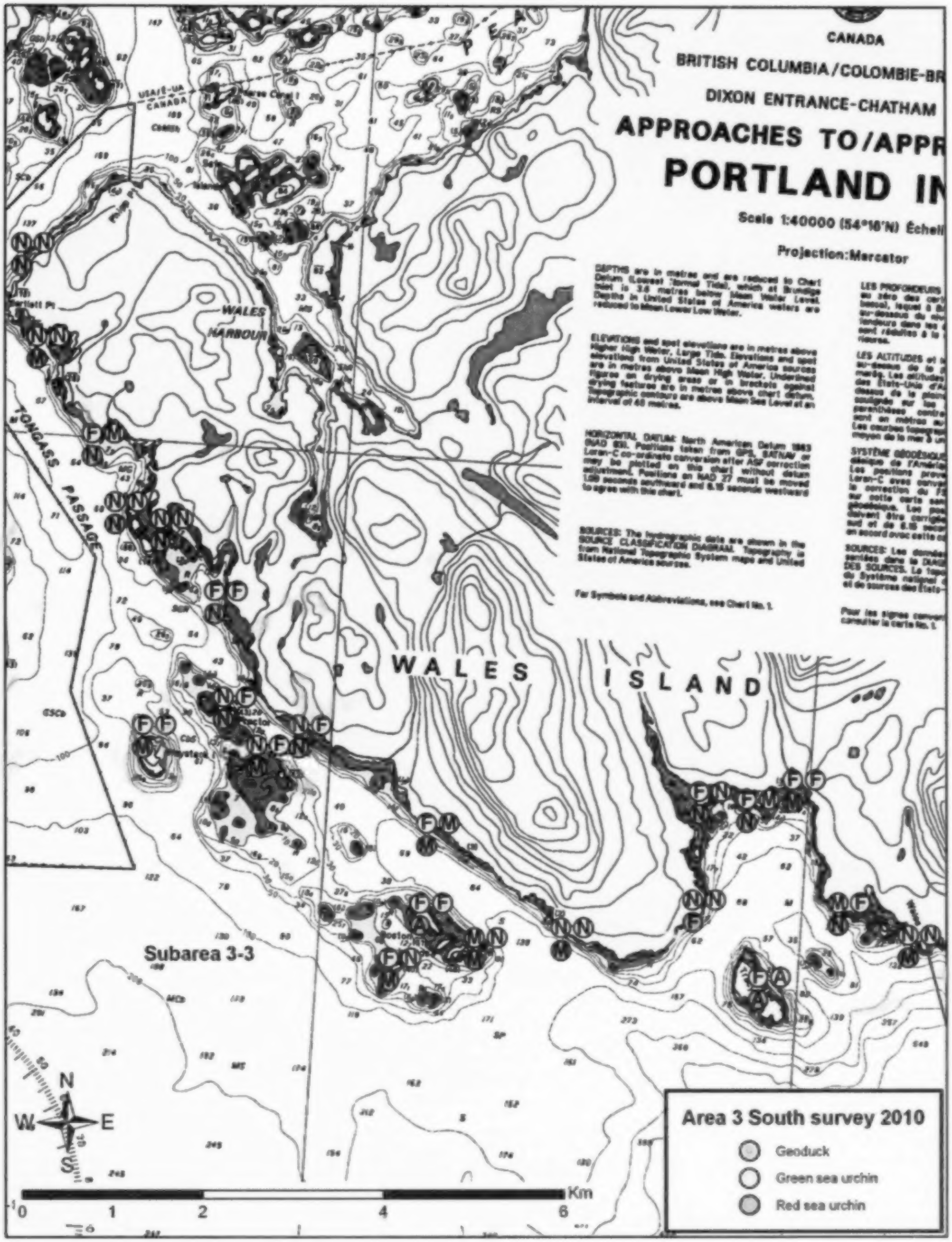

CANADA
BRITISH COLUMBIA/COLOMBIE-BR
DIXON ENTRANCE-CHATHAM
APPROACHES TO/APPR
PORTLAND IN
Scale 1:40000 (54°16'N) Échell
Projection:Mercator
WALES HARBOUR
TONGASS PASSAGE
WALES ISLAND
Subarea 3-3
N
E
S
W
0
1
2
4
6
Km
Area 3 South survey 2010
Geoduck
Green sea urchin
Red sea urchin

Figure 3. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 3–3. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

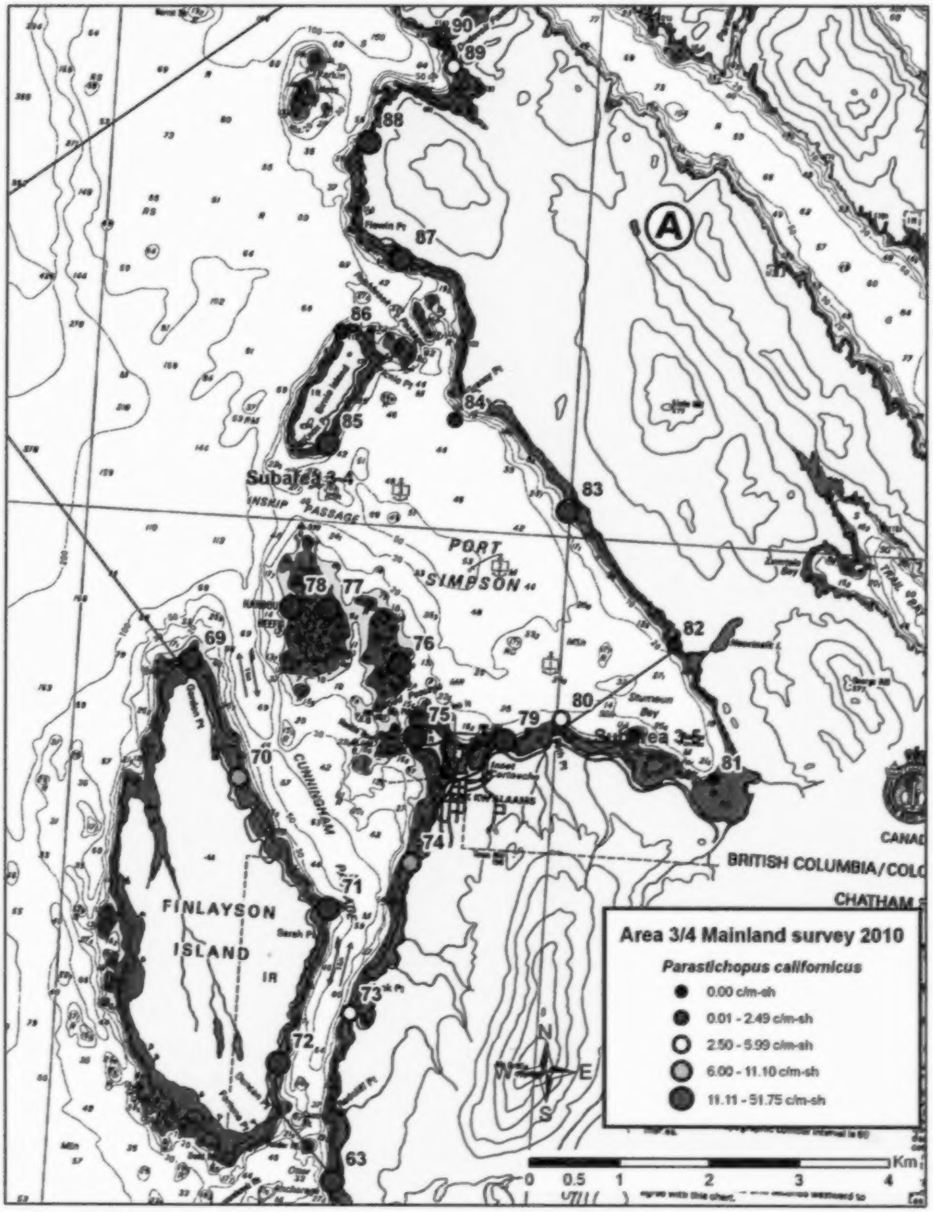

Area 3/4 Mainland survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 11.10 c/m-sh
11.11 - 51.75 c/m-sh
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
69
63
Ⓐ
Subarea 3-4
Subarea 3-5
PORT SIMPSON
FINLAYSON ISLAND
IR
CUNNINGHAM
BRITISH COLUMBIA/COL
CANAD
CHATHAM
N
E
S
W
0
0.5
1
2
3
4
Km

Figure 4. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subareas 3–4 and 3–5, surveyed as part of the Area 3/4 Mainland survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

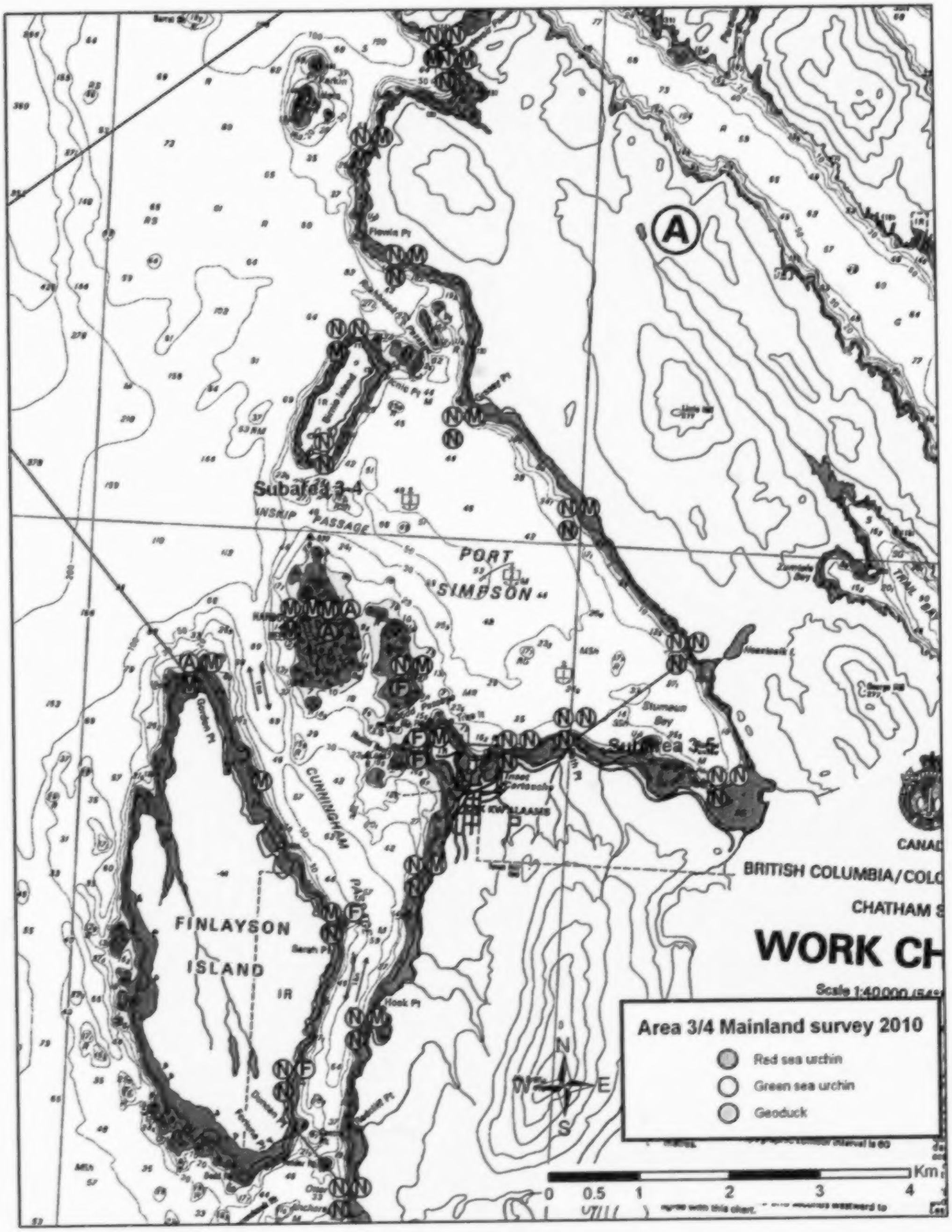

Area 3/4 Mainland survey 2010
Red sea urchin
Green sea urchin
Geoduck
Subarea 3-4
Subarea 3-5
PORT SIMPSON
FINLAYSON ISLAND
CUNNINGHAM
IR
Flewin Pt
Hook Pt
BRITISH COLUMBIA/COL
CHATHAM S
WORK CH
N
S
E
W
0 0.5 1 2 3 4 Km
A
M
F
N

Figure 5. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subareas 3–4 and 3–5. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

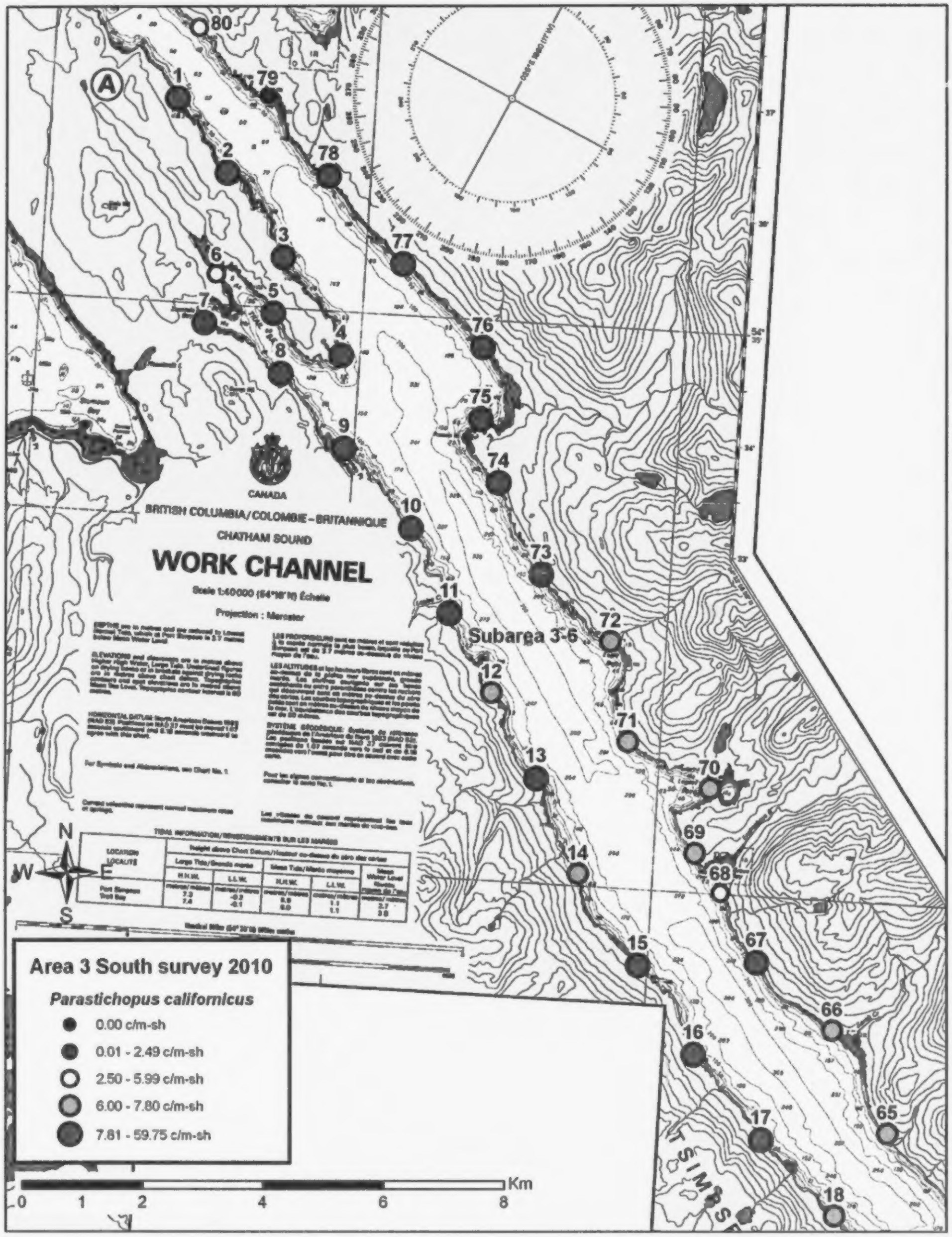

A
80
79
1
2
78
3
77
6
5
7
4
8
76
75
9
74
10
73
11
72
Subarea 3-6
12
71
13
70
69
14
68
15
67
66
16
65
17
18
T SIMS
CANADA
BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE
CHATHAM SOUND
WORK CHANNEL
Scale 1:40 000 (54°18'N) Échelle
Projection : Mercator
N
W
E
S
Area 3 South survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 7.80 c/m-sh
7.81 - 59.75 c/m-sh
0
1
2
4
6
8
Km

Figure 6a. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 3–6, surveyed as part of the Area 3 South survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

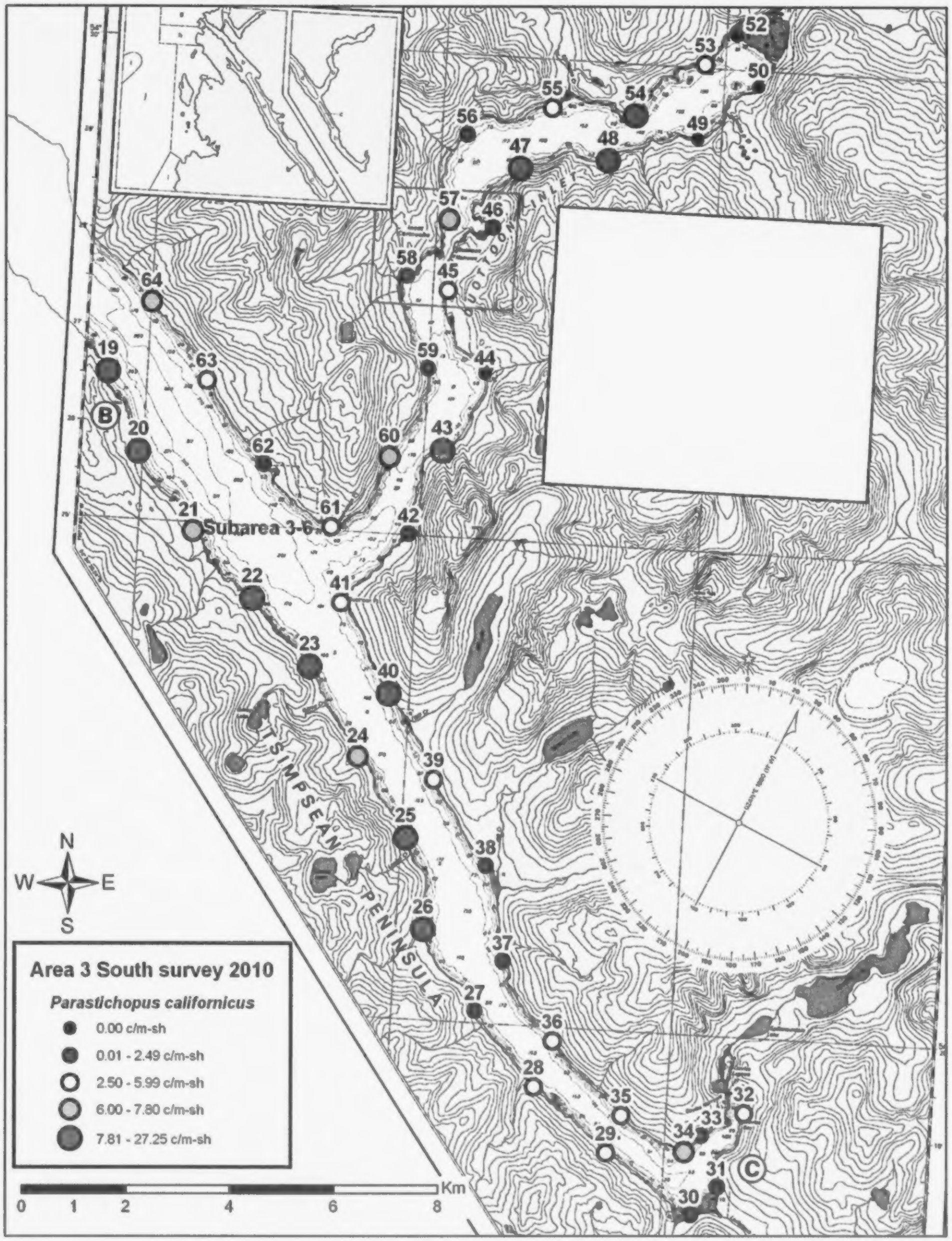

Area 3 South survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 7.80 c/m-sh
7.81 - 27.25 c/m-sh
N
W
E
S
0
1
2
4
6
8
Km
Subarea 3-6
B
C
TSIMPSEAN PENINSULA
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
52
53
54
55
56
57
58
59
60
61
62
63
64

Figure 6b. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 3–6, surveyed as part of the Area 3 South survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

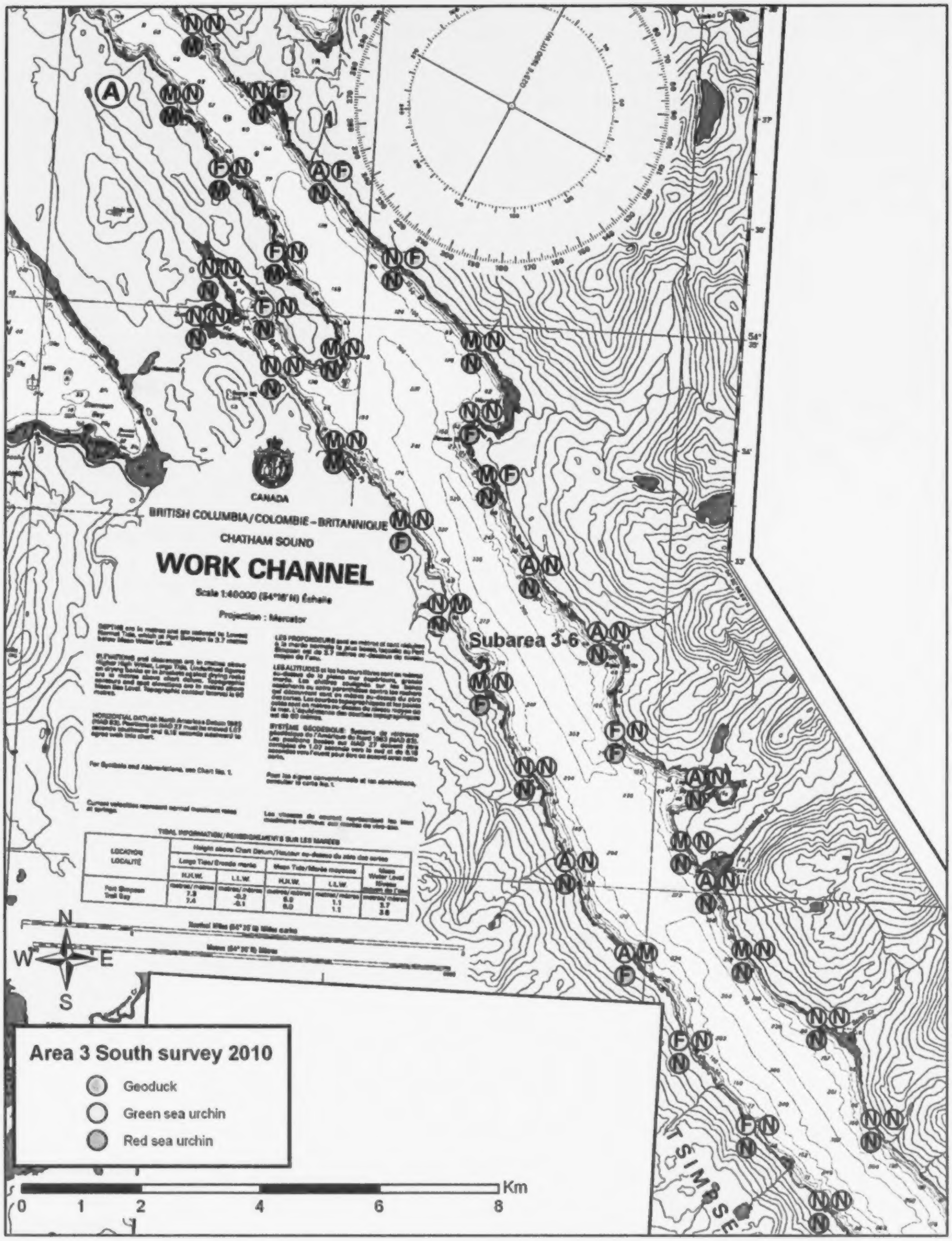

CANADA
BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE
CHATHAM SOUND
WORK CHANNEL
Subarea 3-6
N
W
E
S
Area 3 South survey 2010
Geoduck
Green sea urchin
Red sea urchin
0
1
2
4
6
8
Km

Figure 7a. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in a portion of PFMA Subarea 3–6. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

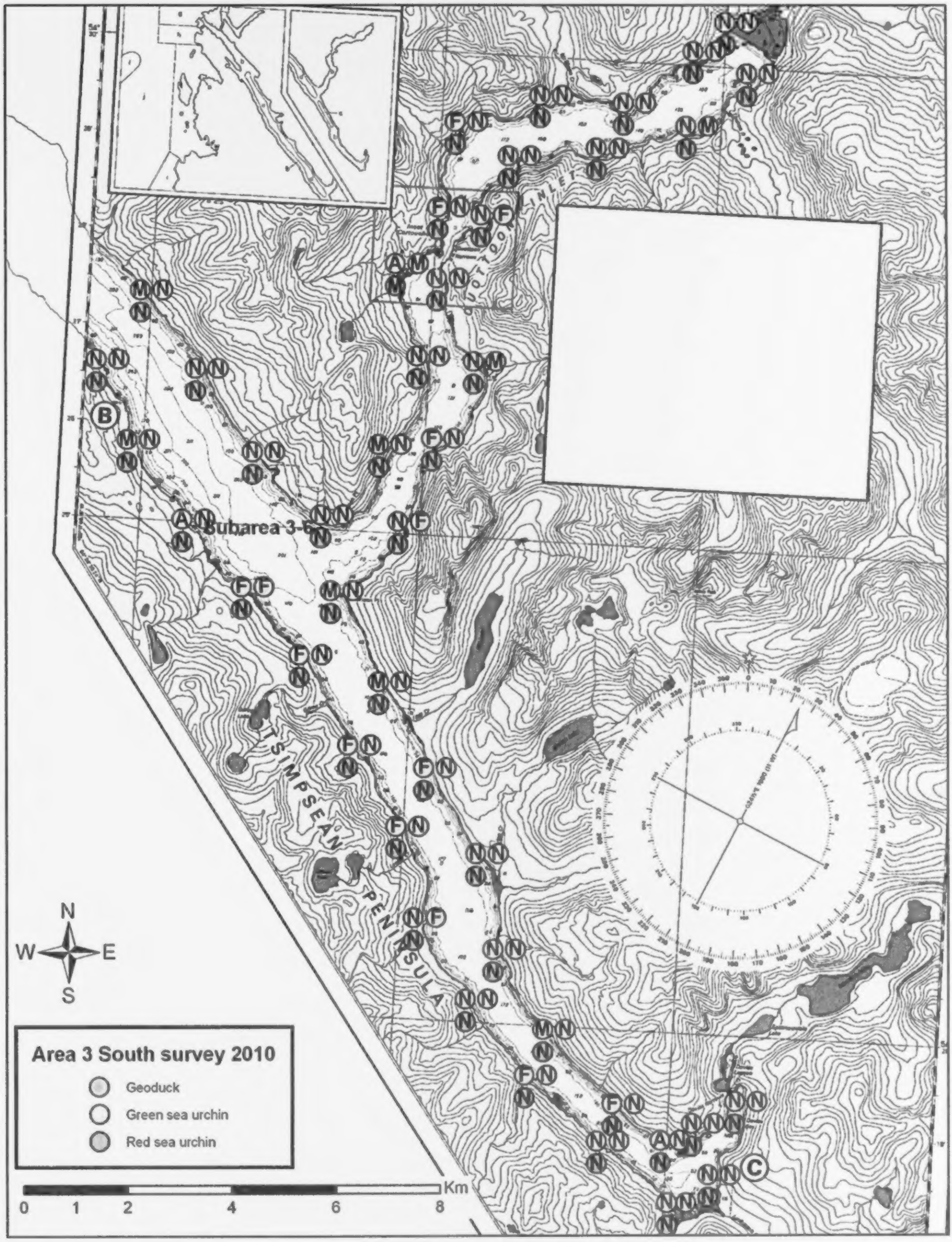

Subarea 3-6
TSIMPSEAN PENINSULA
B
C
N
W
E
S
Area 3 South survey 2010
Geoduck
Green sea urchin
Red sea urchin
0 1 2 4 6 8
Km

Figure 7b. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in a portion of PFMA Subarea 3–6. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

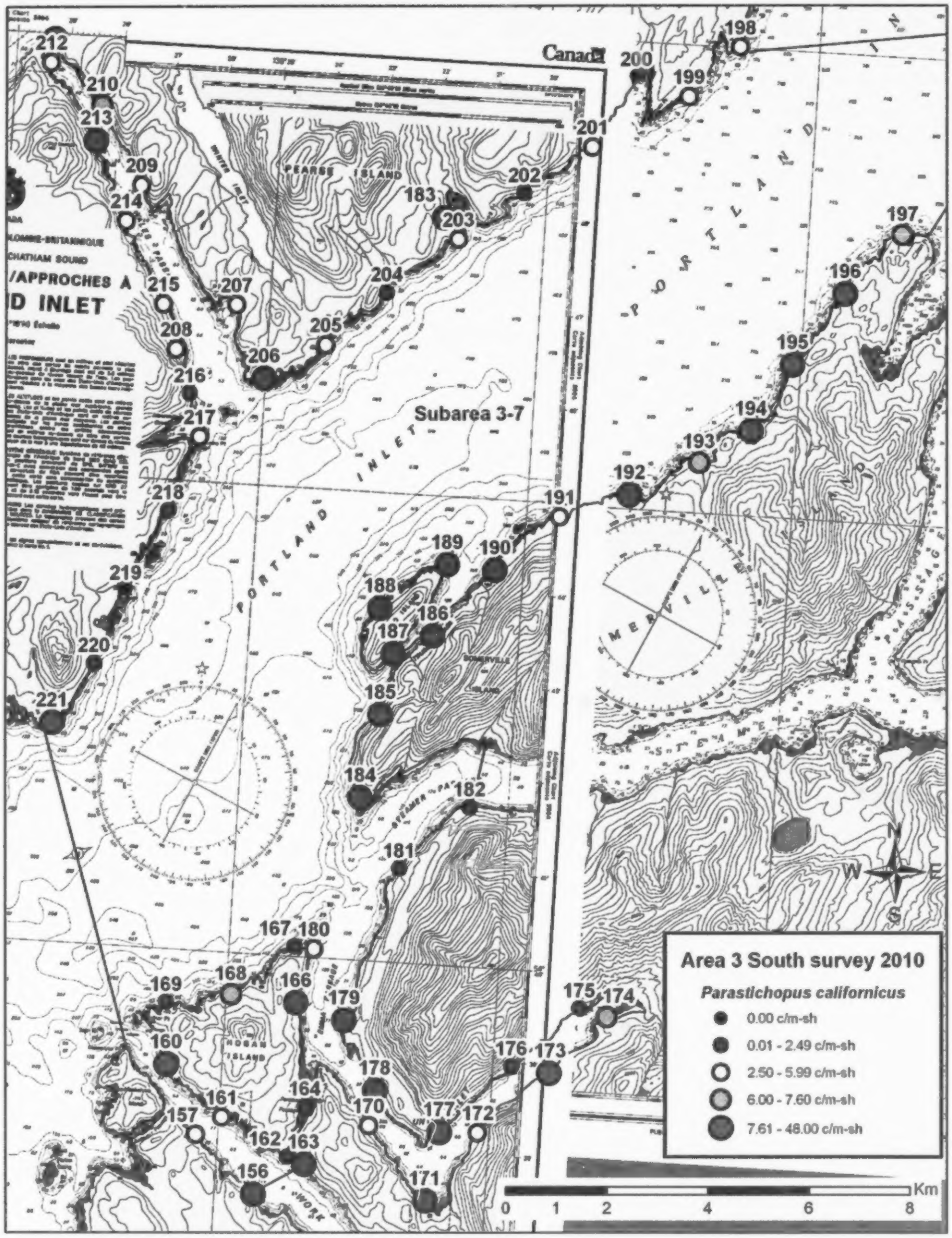

212
210
213
209
214
215
207
208
206
216
217
218
219
220
221
Canada
200
198
199
201
202
183
203
204
205
197
196
195
194
193
192
191
Subarea 3-7
189
190
188
186
187
185
184
182
181
167
180
168
166
169
179
175
174
160
178
176
173
164
161
157
170
177
172
162
163
156
171
N
W
E
S
Area 3 South survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 7.60 c/m-sh
7.61 - 48.00 c/m-sh
0
1
2
4
6
8
Km

Figure 8. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 3–7, surveyed as part of the Area 3 South survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

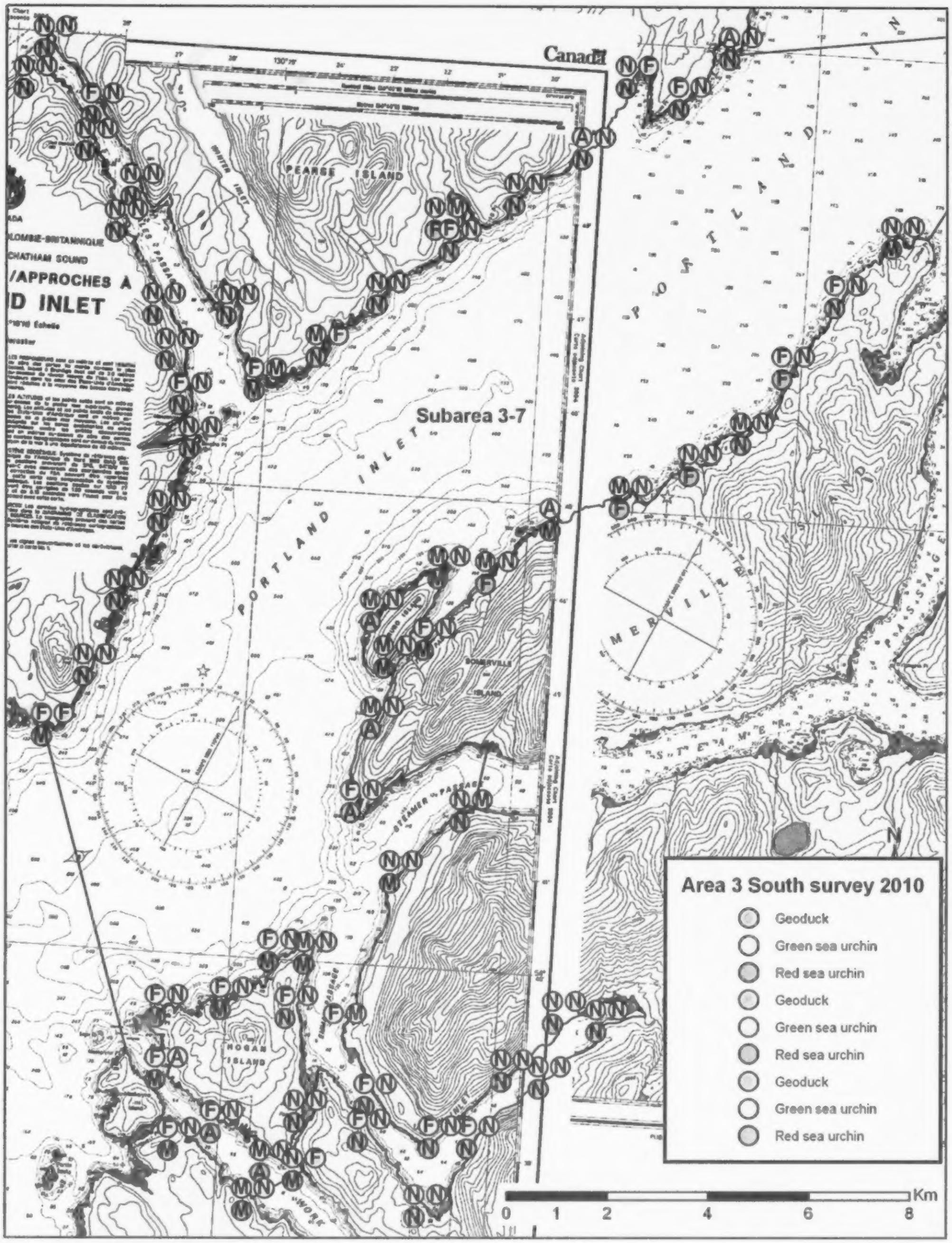

Canada
PEARSE ISLAND
/APPROCHES A
D INLET
Subarea 3-7
INLET
PORTLAND
PORTLAND INLET
SOMERVILLE ISLAND
SOMERVILLE
STEAMER PASSAGE
HOGAN ISLAND
Area 3 South survey 2010
Geoduck
Green sea urchin
Red sea urchin
Geoduck
Green sea urchin
Red sea urchin
Geoduck
Green sea urchin
Red sea urchin
0
1
2
4
6
8
Km

Figure 9. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 3–7. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

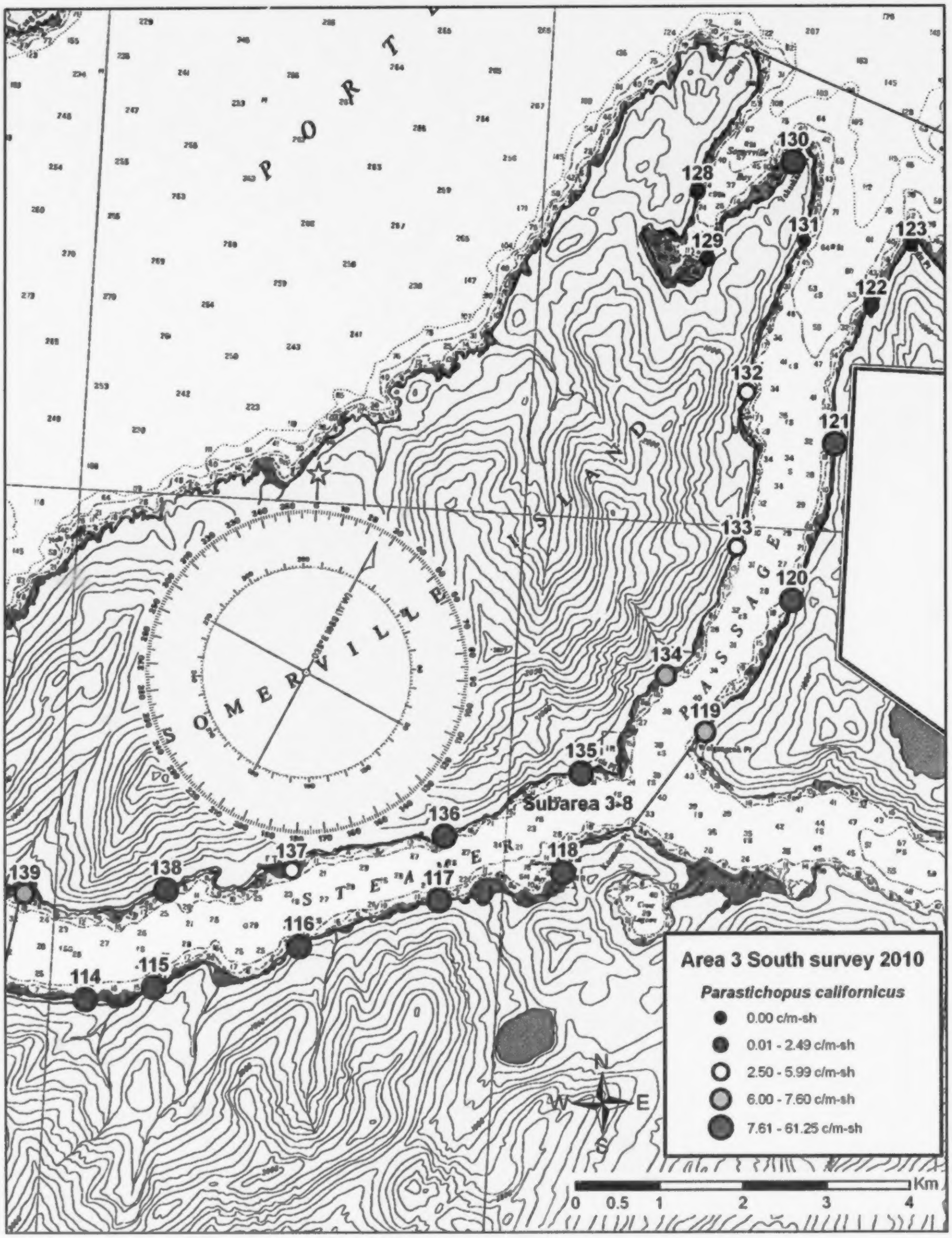

Area 3 South survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 7.60 c/m-sh
● 7.61 - 61.25 c/m-sh
Subarea 3-8
114
115
116
117
118
119
120
121
122
123
128
129
130
131
132
133
134
135
136
137
138
139
N
W
E
S
0 0.5 1 2 3 4 Km

Figure 10. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 3–8, surveyed as part of the Area 3 South survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

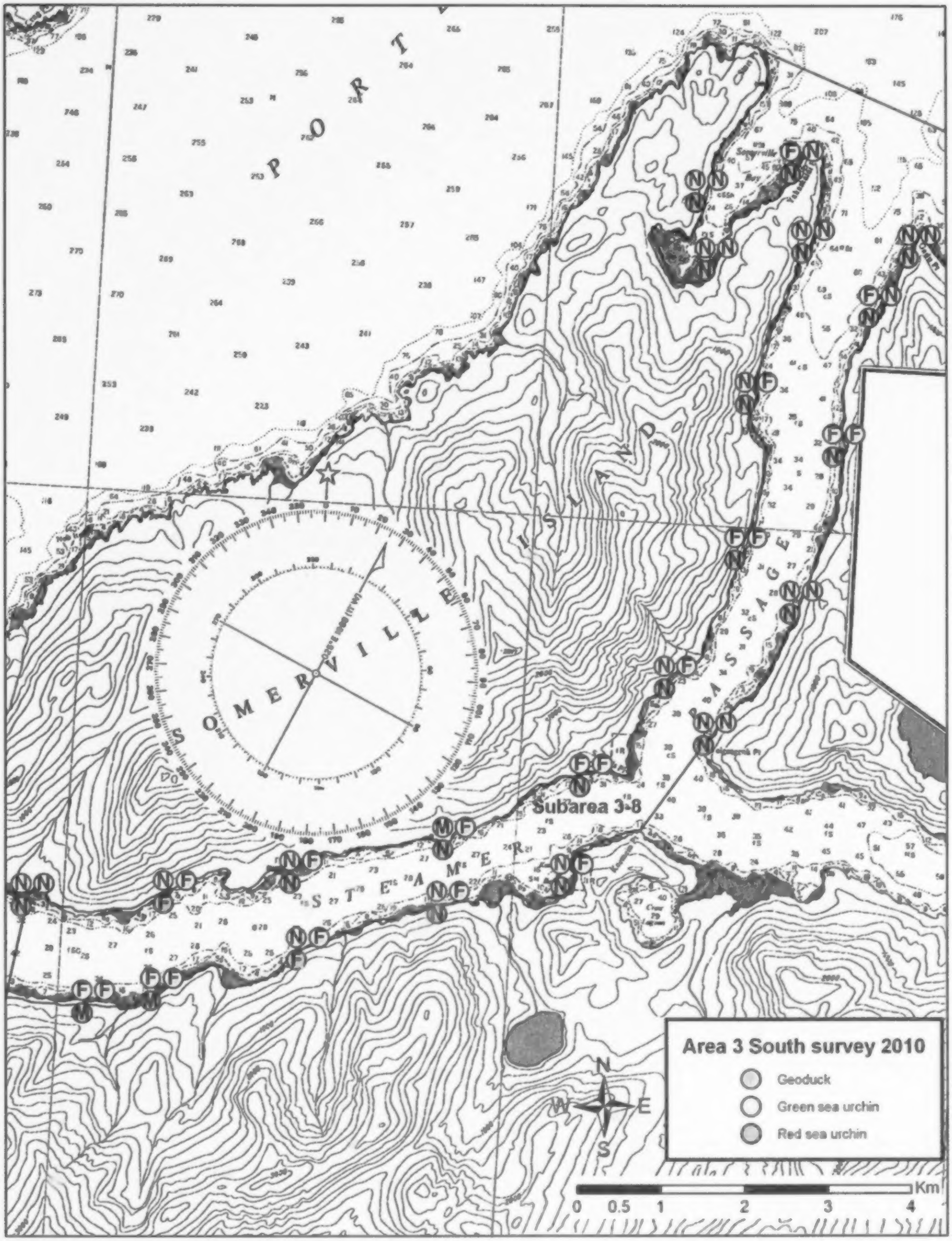

PORT
SOMERVILLE ISLAND
STEAMER PASSAGE
Subarea 3-8
Area 3 South survey 2010
Geoduck
Green sea urchin
Red sea urchin
N
E
S
W
Km
0
0.5
1
2
3
4

Figure 11. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 3–8. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

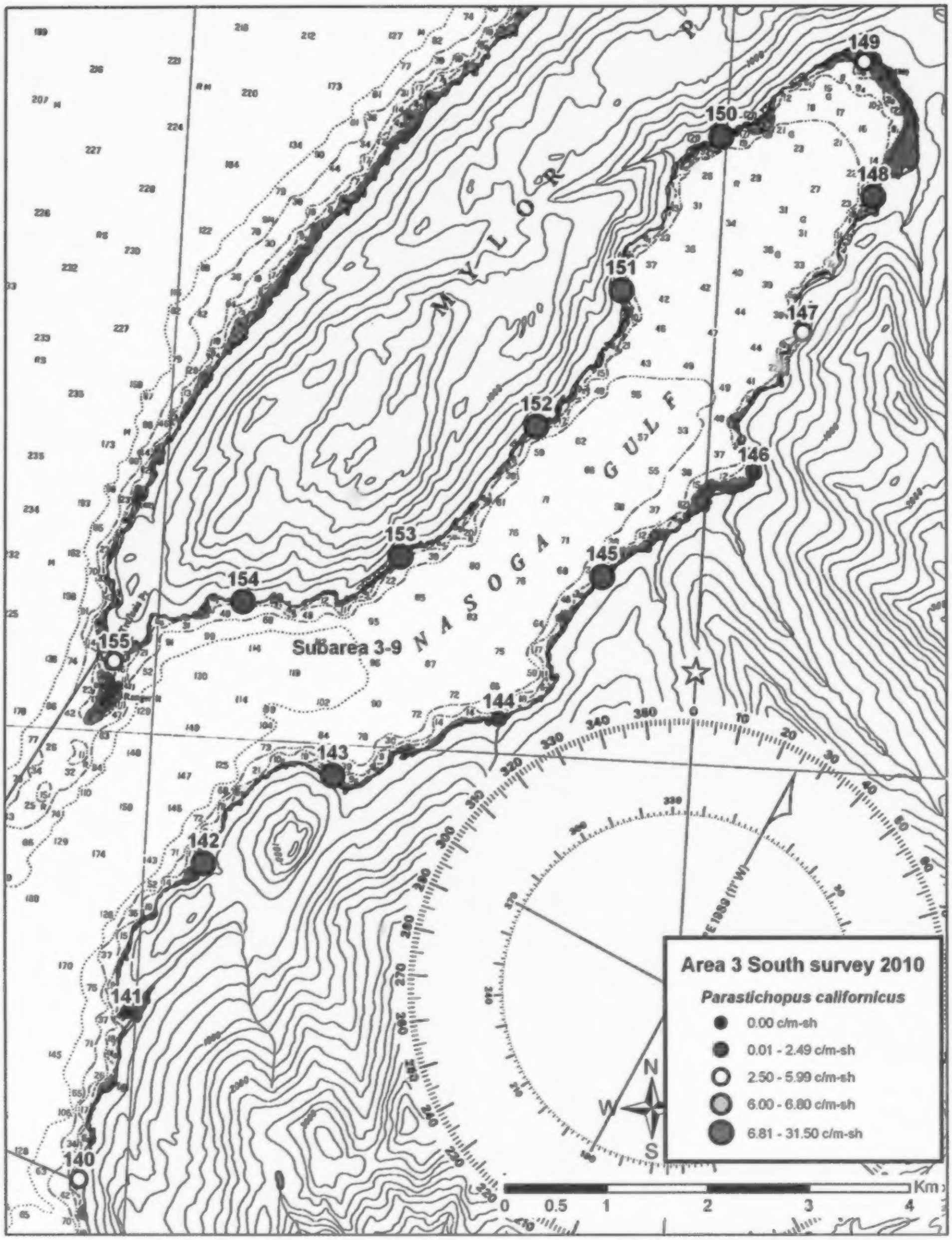

MYLOR P
NASOGA GULF
Subarea 3-9
149
150
148
151
147
152
146
153
145
154
155
144
143
142
141
140
N
W
S
Area 3 South survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 6.80 c/m-sh
6.81 - 31.50 c/m-sh
0
0.5
1
2
3
4
Km

Figure 12. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 3–9, surveyed as part of the Area 3 South survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

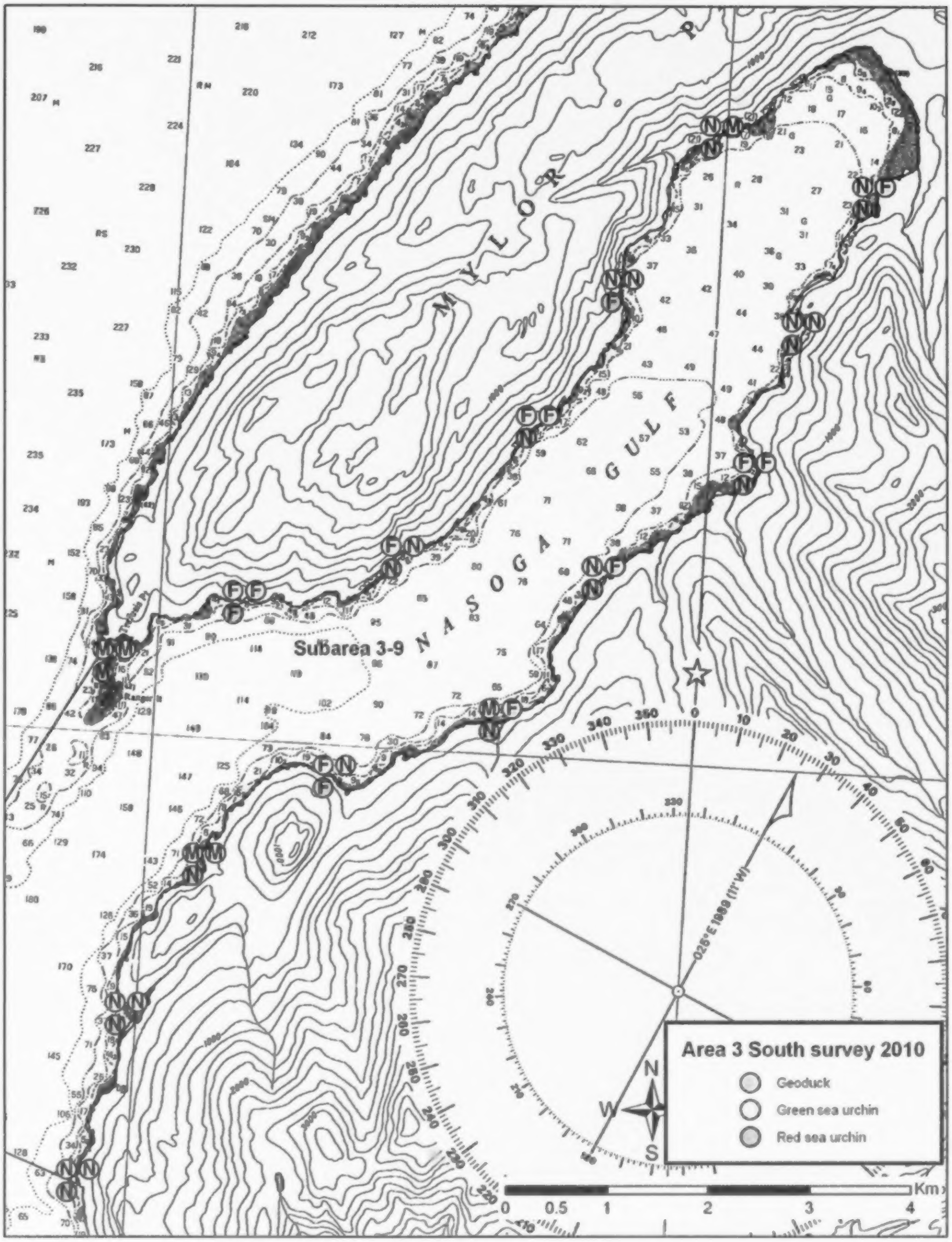

MYLOR P
NASOGA GULF
Subarea 3-9
Area 3 South survey 2010
Geoduck
Green sea urchin
Red sea urchin
N
W
S
0 0.5 1 2 3 4 Km

Figure 13. Abundances of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 3–9. The total number of animals observed while swimming the transect is noted and given an abundance scale of A, M, F, or 0. A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

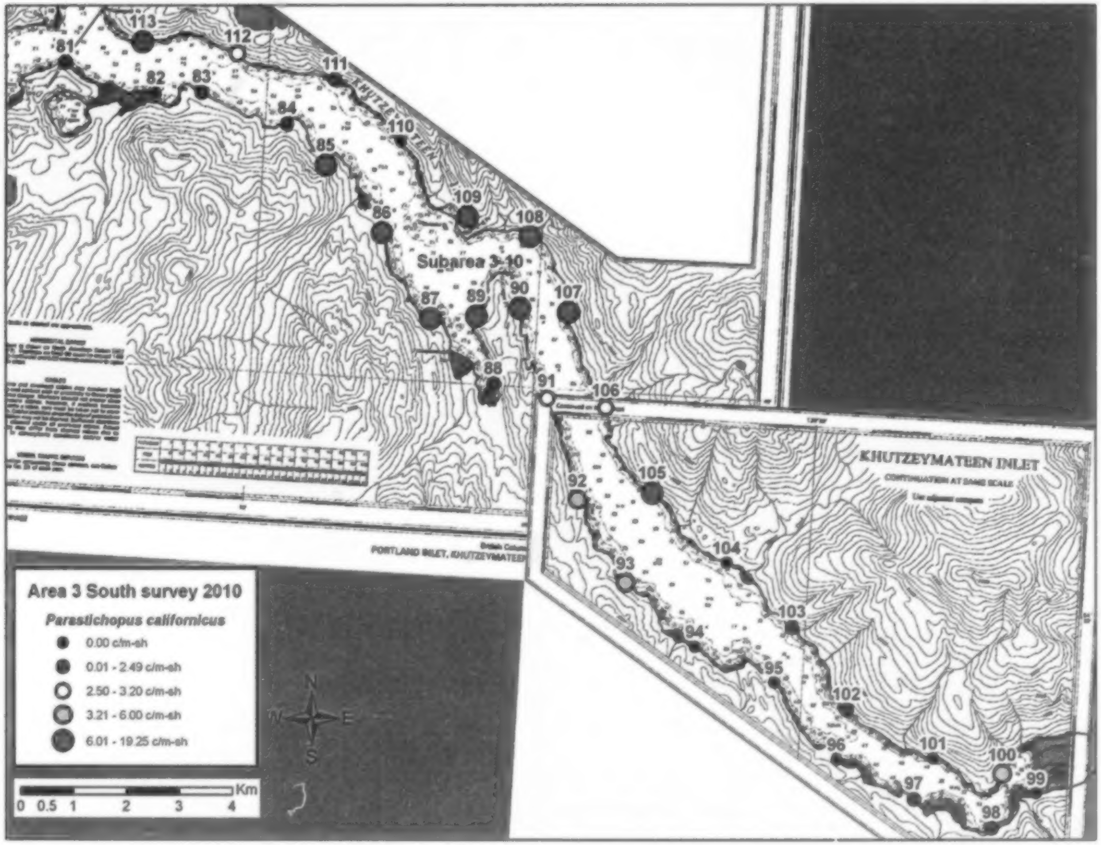

113
112
81
82
83
111
84
110
85
109
86
108
Subarea 3-10
87
89
90
107
88
91
106
KHUTZEYMATEEN INLET
92
105
104
93
103
94
95
102
96
101
100
99
97
98
PORTLAND INLET, KHUTZEYMATEEN
Area 3 South survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 3.20 c/m-sh
3.21 - 6.00 c/m-sh
6.01 - 19.25 c/m-sh
N
W
E
S
0 0.5 1 2 3 4 Km

Figure 14. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 3–10, surveyed as part of the Area 3 South survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and the bootstrapped 90% lower confidence bound calculated for the Subarea, 3.20 c/m-sh); green = productive locations (between 3.21 c/m-sh and the baseline regional density for the North Coast); blue = very productive locations (densities above the baseline regional density for the North Coast).

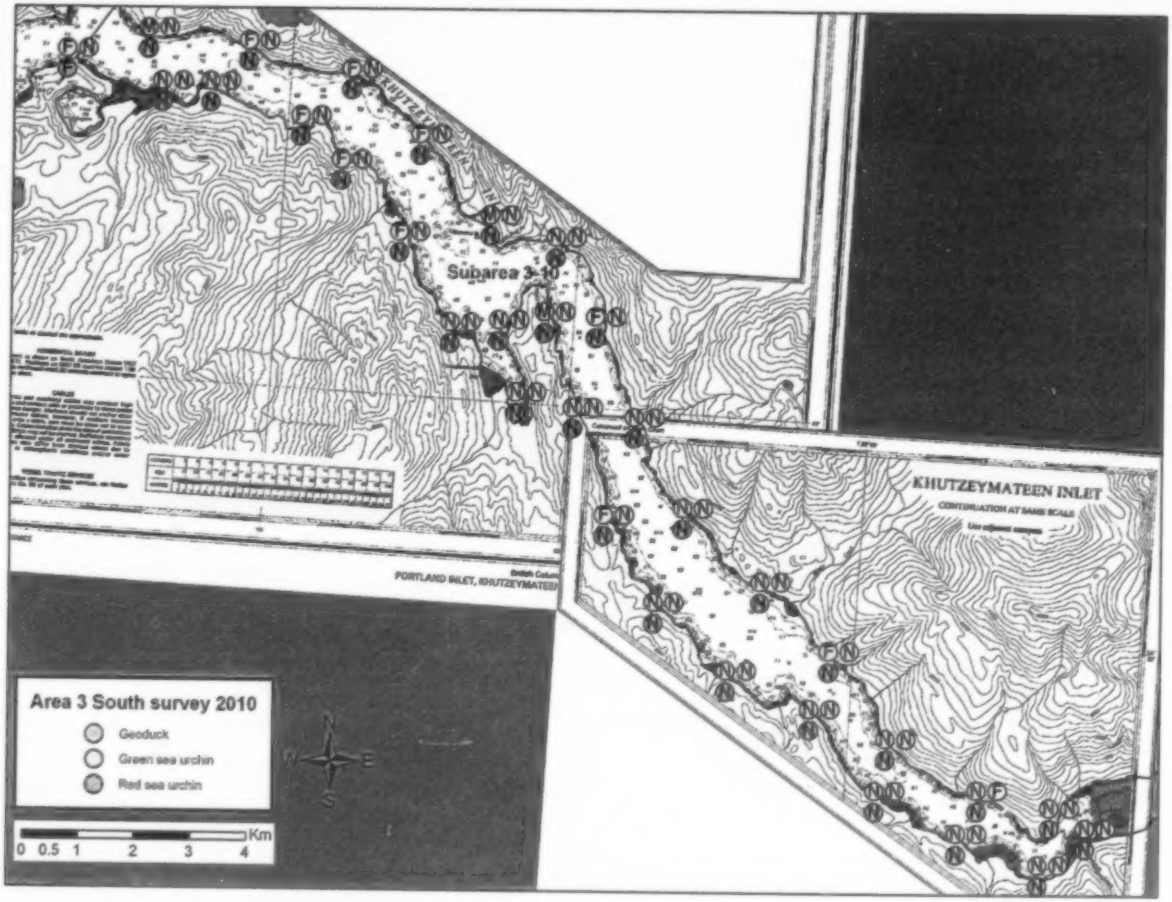

Subarea 3-10
KHUTZEYMATEEN INLET
CONTINUATION AT SAME SCALE
PORTLAND INLET, KHUTZEYMATEEN
Area 3 South survey 2010
Geoduck
Green sea urchin
Red sea urchin
N
W
E
S
0 0.5 1 2 3 4 Km

Figure 15. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 3–10. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

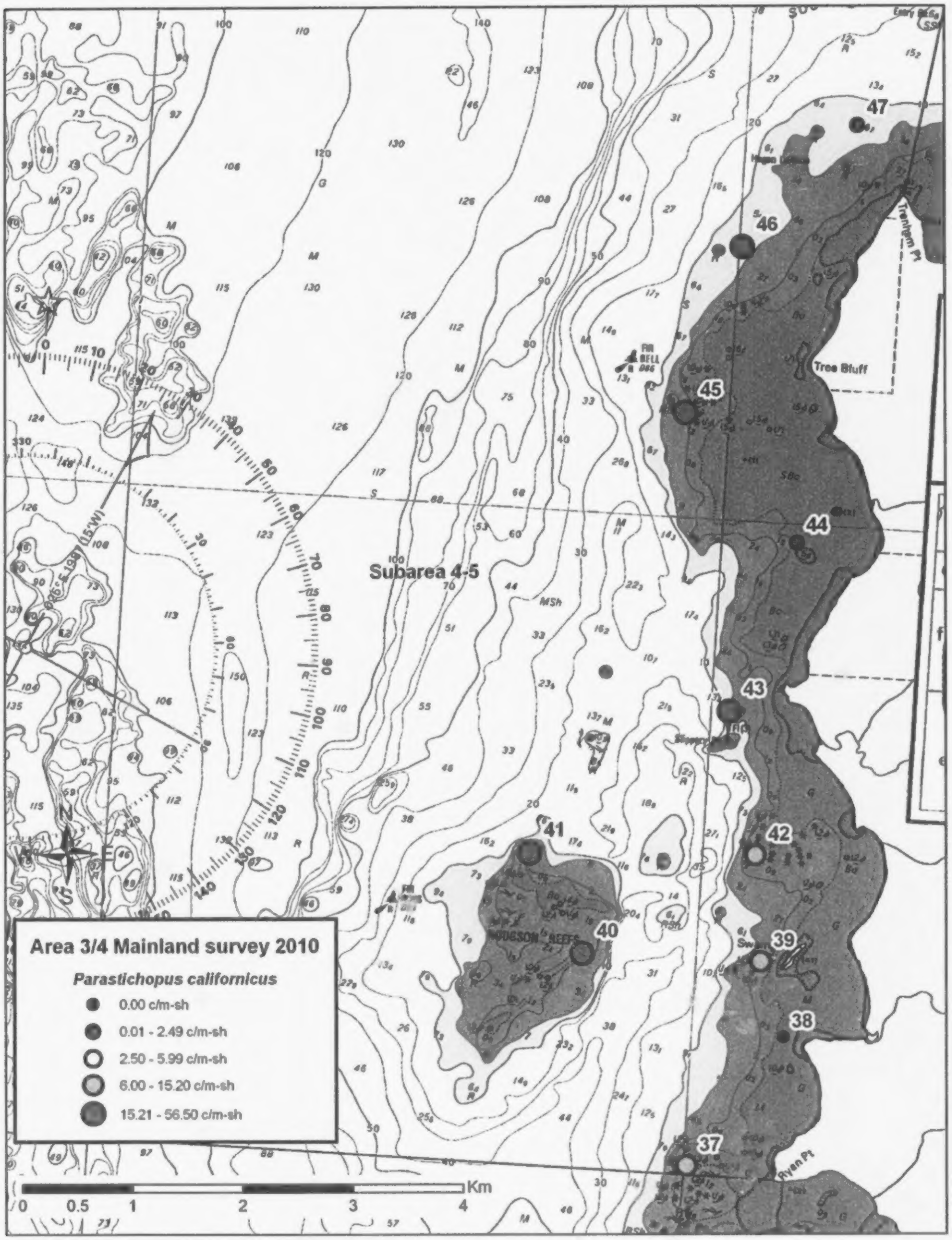

Area 3/4 Mainland survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 15.20 c/m-sh
● 15.21 - 56.50 c/m-sh
Subarea 4-5
47
46
45
44
43
42
41
40
39
38
37
Tree Bluff
Trenham Pt
Ryan Pt
HODGSON REEFS
0 0.5 1 2 3 4 Km

Figure 16a. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 4–5, surveyed as part of the Area 3/4 Mainland survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

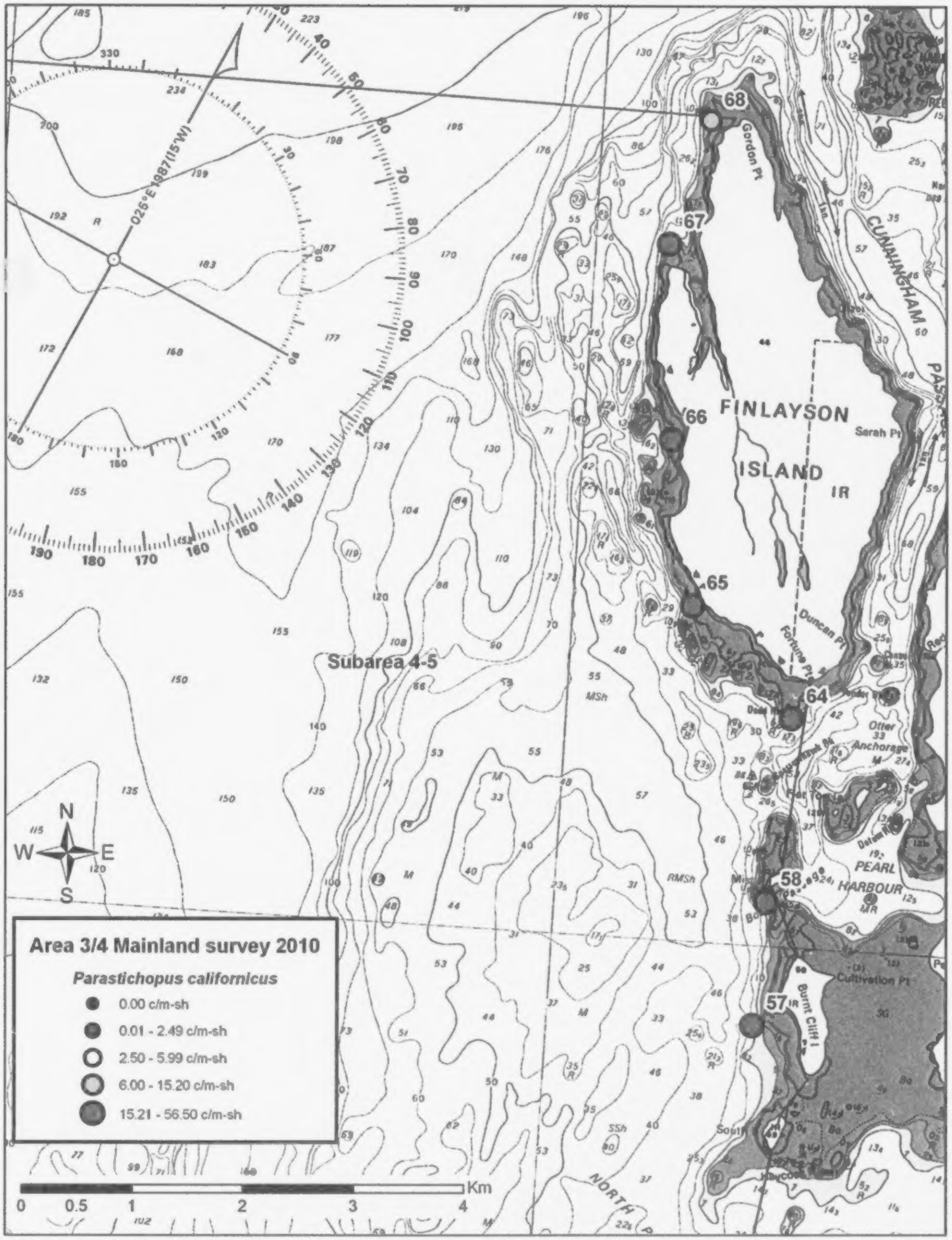

Area 3/4 Mainland survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 15.20 c/m-sh
● 15.21 - 56.50 c/m-sh
68
67
66
65
64
58
57
FINLAYSON
ISLAND
IR
Subarea 4-5
Gordon Pt
CUNNINGHAM
PASSAGE
Sarah Pt
Duncan Pt
Fortune Pt
Otter
Anchorage
PEARL
HARBOUR
Cultivation Pt
Burnt Cliff I
NORTH
026°E 1987(15'W)
N
W
E
S
0 0.5 1 2 3 4
Km

Figure 16b. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 4–5, surveyed as part of the Area 3/4 Mainland survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

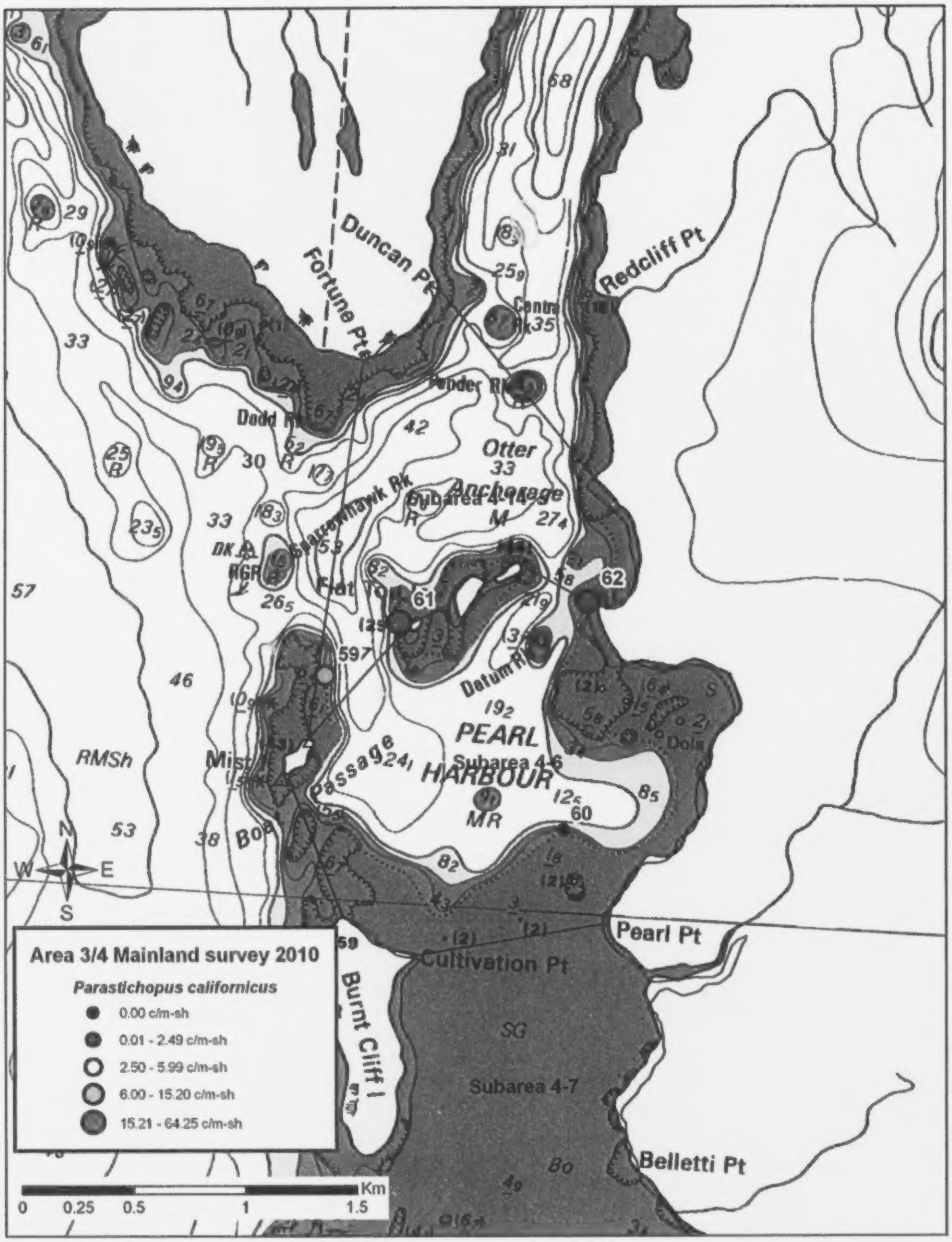

Area 3/4 Mainland survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 15.20 c/m-sh
● 15.21 - 64.25 c/m-sh
0
0.25
0.5
1
1.5
Km
N
S
E
W
Duncan Pt
Fortune Pt
Redcliff Pt
Centre Rk
Pender Rk
Dodd Rk
Otter Anchorage
Subarea 4-14
Sparrowhawk Rk
Flat Top
Datum Rk
PEARL HARBOUR
Subarea 4-6
Passage
Mist
Pearl Pt
Cultivation Pt
Burnt Cliff I
Subarea 4-7
Belletti Pt
Dola
RMSh
SG
Bo
MR
35
59
60
61
62
597

Figure 16c. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subareas 4–6 and 4–14, surveyed as part of the Area 3/4 Mainland survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

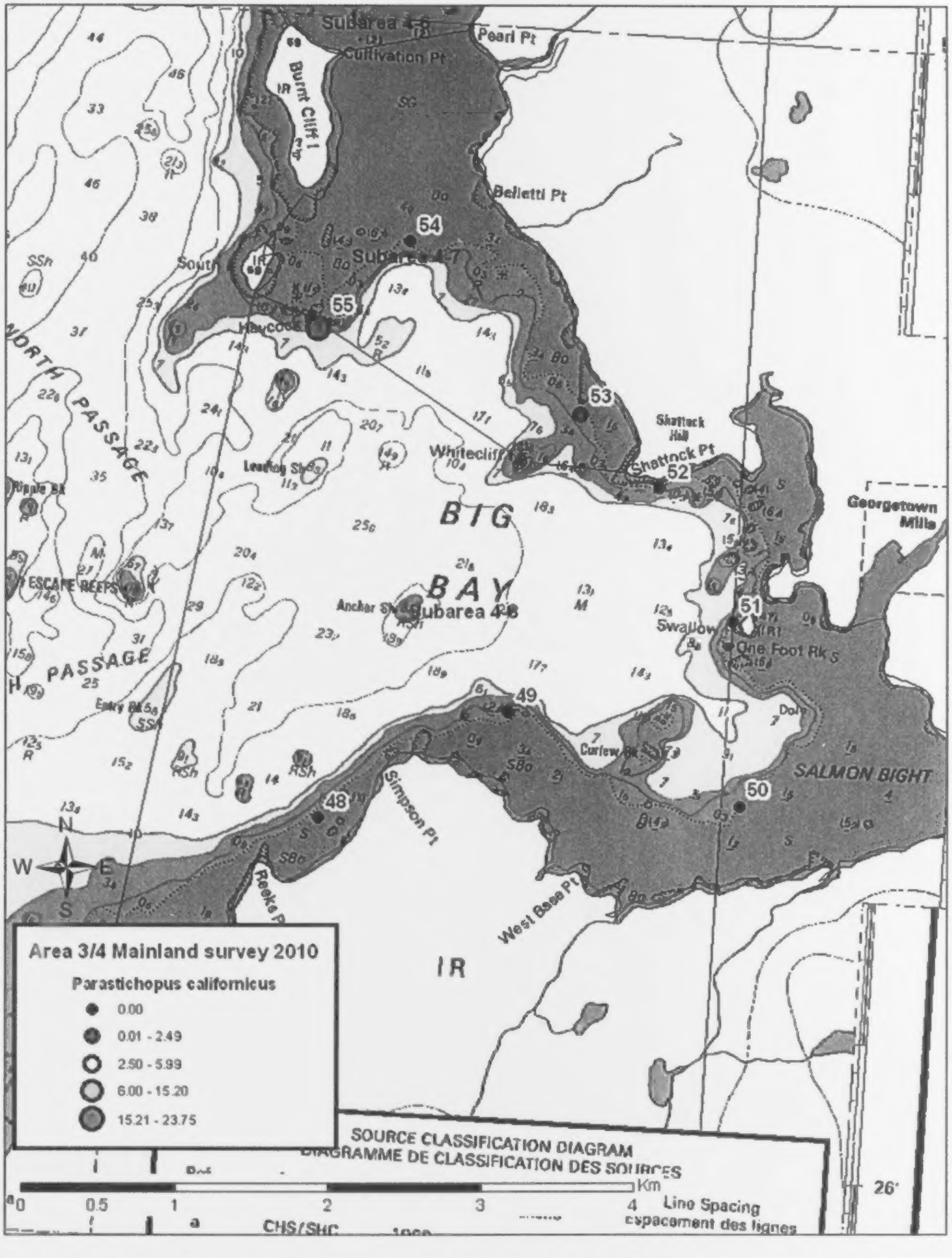
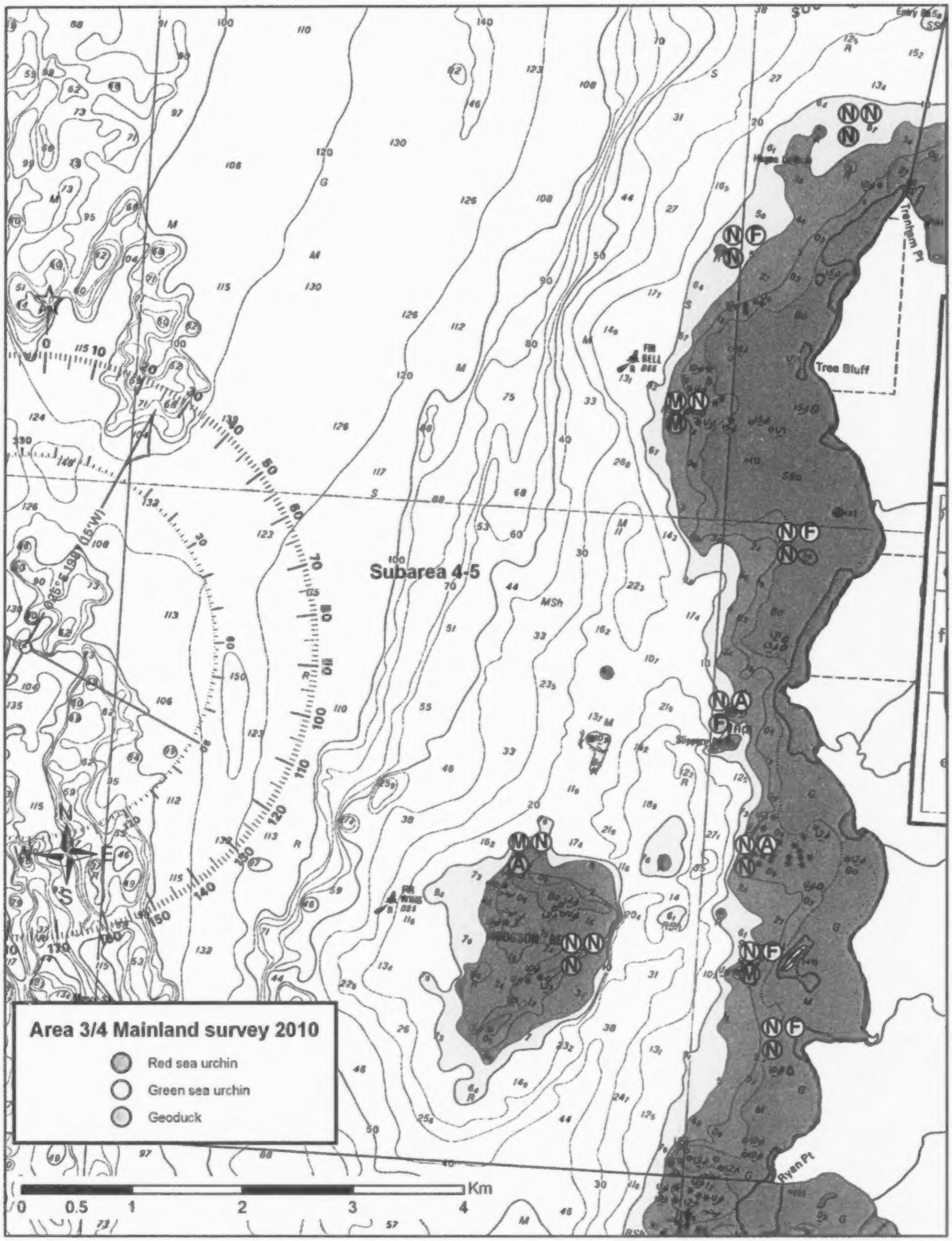

Pearl Pt
Cultivation Pt
Burnt Cliff I
Belletti Pt
54
Subarea 4-7
55
Haycock
NORTH PASSAGE
53
Shattock Hill
Shattock Pt
52
Whitecliff
Leading Sh
BIG BAY
Subarea 4-8
Anchor Sh
Georgetown Mills
51
Swallow
One Foot Rk
ESCAPE REEFS
PASSAGE
Ripple Rk
Entry Bk
49
Curlew
SALMON BIGHT
50
48
Simpson Pt
Reeks P
West Base Pt
IR
N
W
E
S
Area 3/4 Mainland survey 2010
Parastichopus californicus
0.00
0.01 - 2.49
2.50 - 5.99
6.00 - 15.20
15.21 - 23.75
SOURCE CLASSIFICATION DIAGRAM
DIAGRAMME DE CLASSIFICATION DES SOURCES
0
0.5
1
2
3
4
Km
Line Spacing
espacement des lignes
CHS/SHC

Figure 16d. Linear density of *Parastichopus californicus* in the PFMA Subareas 4-7 and 4-8 surveyed as part of the Area 3/4 Mainland survey in 2010. Each coloured dot indicates the locations of a survey transect; the number is indicated above the dot. Black = zero; red = low density (<2.5 sc/m-sh); yellow = medium density (between 2.5 and 5.99 sc/m-sh); green = productive locations (between 6.00 sc/m-sh and the bootstrapped lower 90% bounds calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound).



Subarea 4-5
Area 3/4 Mainland survey 2010
● Red sea urchin
○ Green sea urchin
● Geoduck
Tree Bluff
Trentham Pt
Ryan Pt
0 0.5 1 2 3 4 Km
N
E
S
W

Figure 17a. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 4–5. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

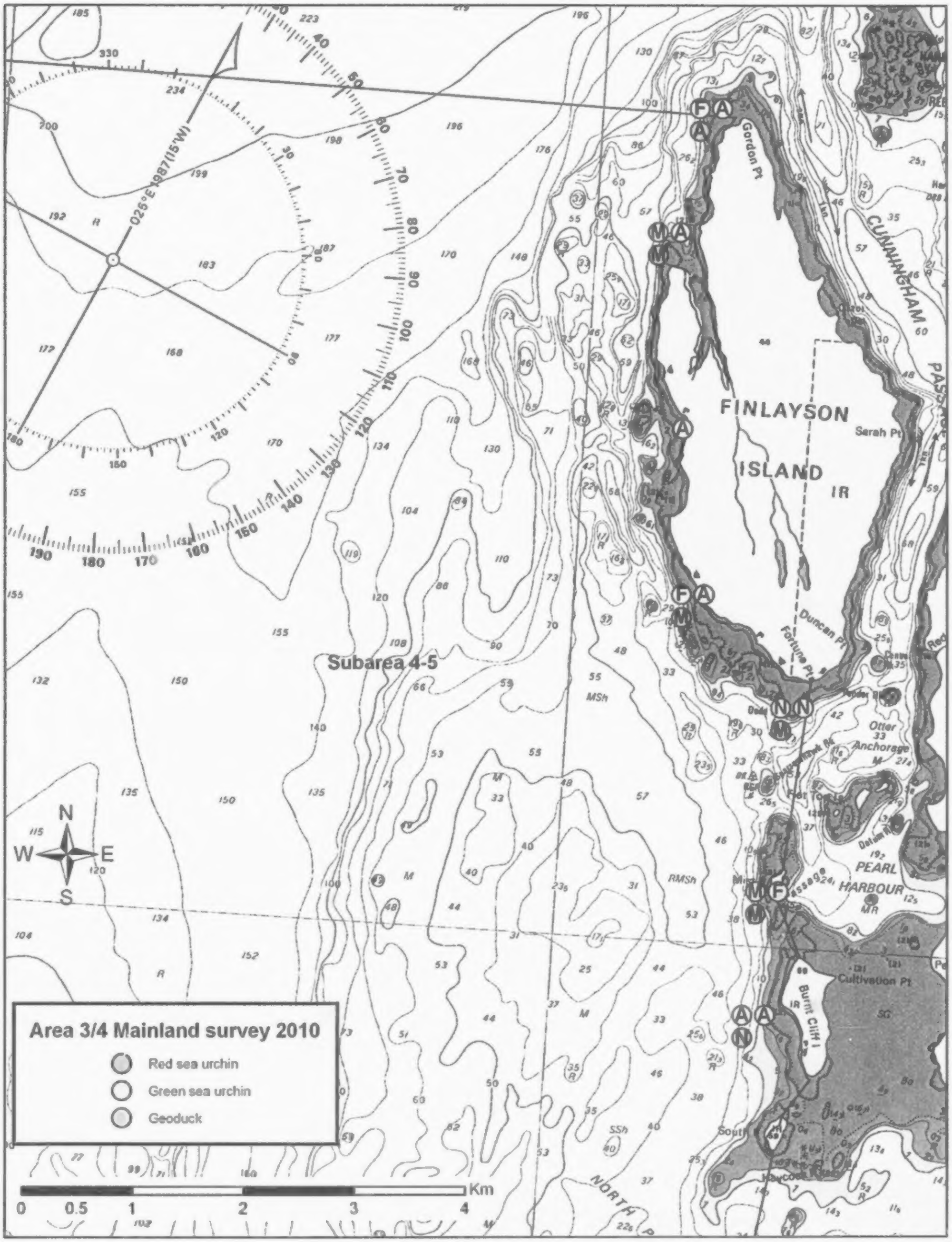

Area 3/4 Mainland survey 2010
Red sea urchin
Green sea urchin
Geoduck
Subarea 4-5
FINLAYSON
ISLAND
IR
Gordon Pt
CUNNINGHAM
Sarah Pt
Duncan Pt
Fortune Pt
Otter
Anchorage
PEARL
HARBOUR
Cultivation Pt
Burnt Cliff I
NORTH
026°E 1987(15°W)
N
W
E
S
Km
0
0.5
1
2
3
4

Figure 17b. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 4–5. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

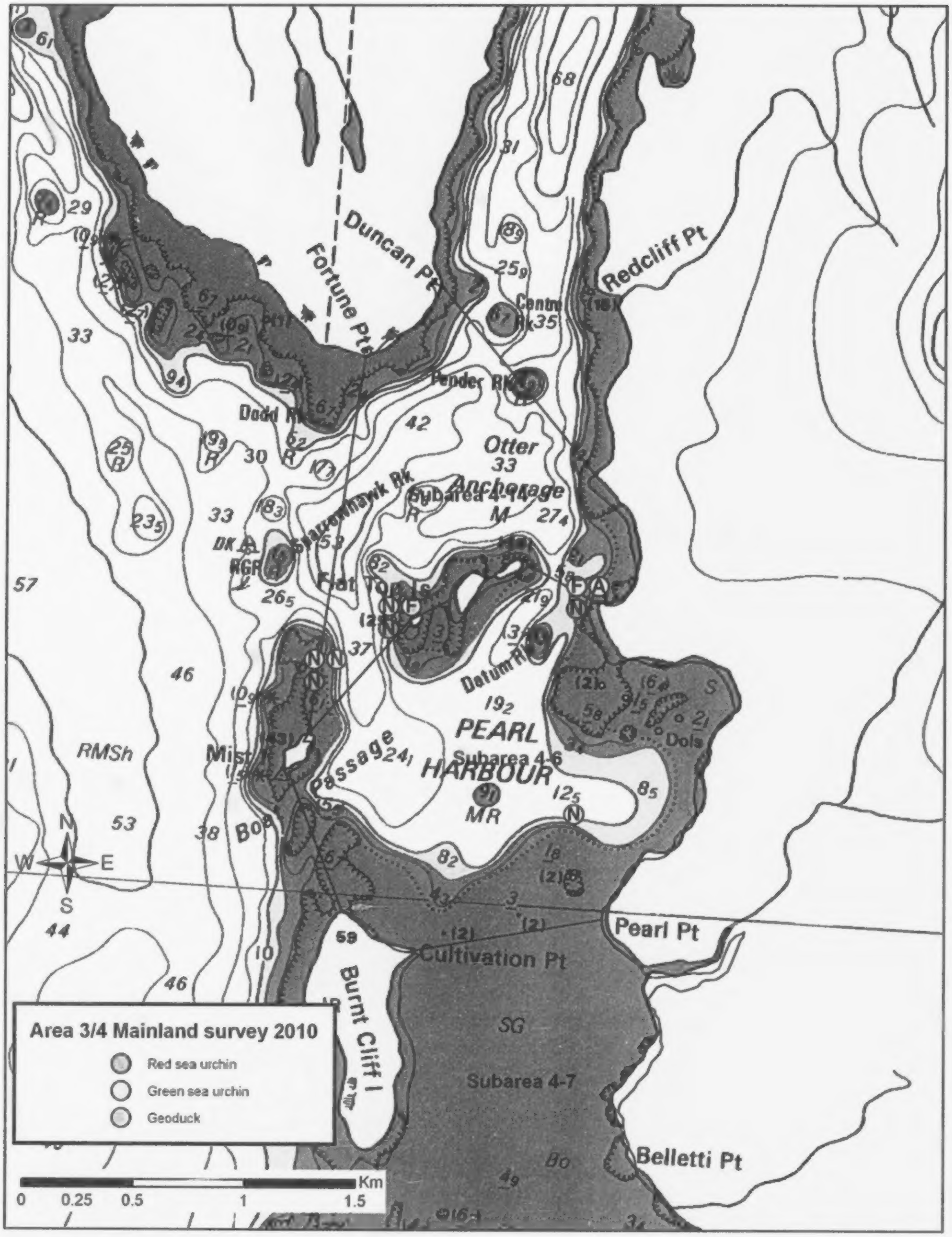

Duncan Pt
Fortune Pt
Redcliff Pt
Centre Rk
Pender Rk
Dodd Rk
Sparrowhawk Rk
Otter Anchorage
Subarea 4-14
Flat Top Is
Datum Rk
PEARL HARBOUR
Subarea 4-6
Dols
Mist Is
Passage
Bob
Pearl Pt
Cultivation Pt
Burnt Cliff I
Subarea 4-7
Belletti Pt
RMSh
N
W
E
S
Area 3/4 Mainland survey 2010
Red sea urchin
Green sea urchin
Geoduck
0
0.25
0.5
1
1.5
Km

Figure 17c. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subareas 4–6 and 4–14. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

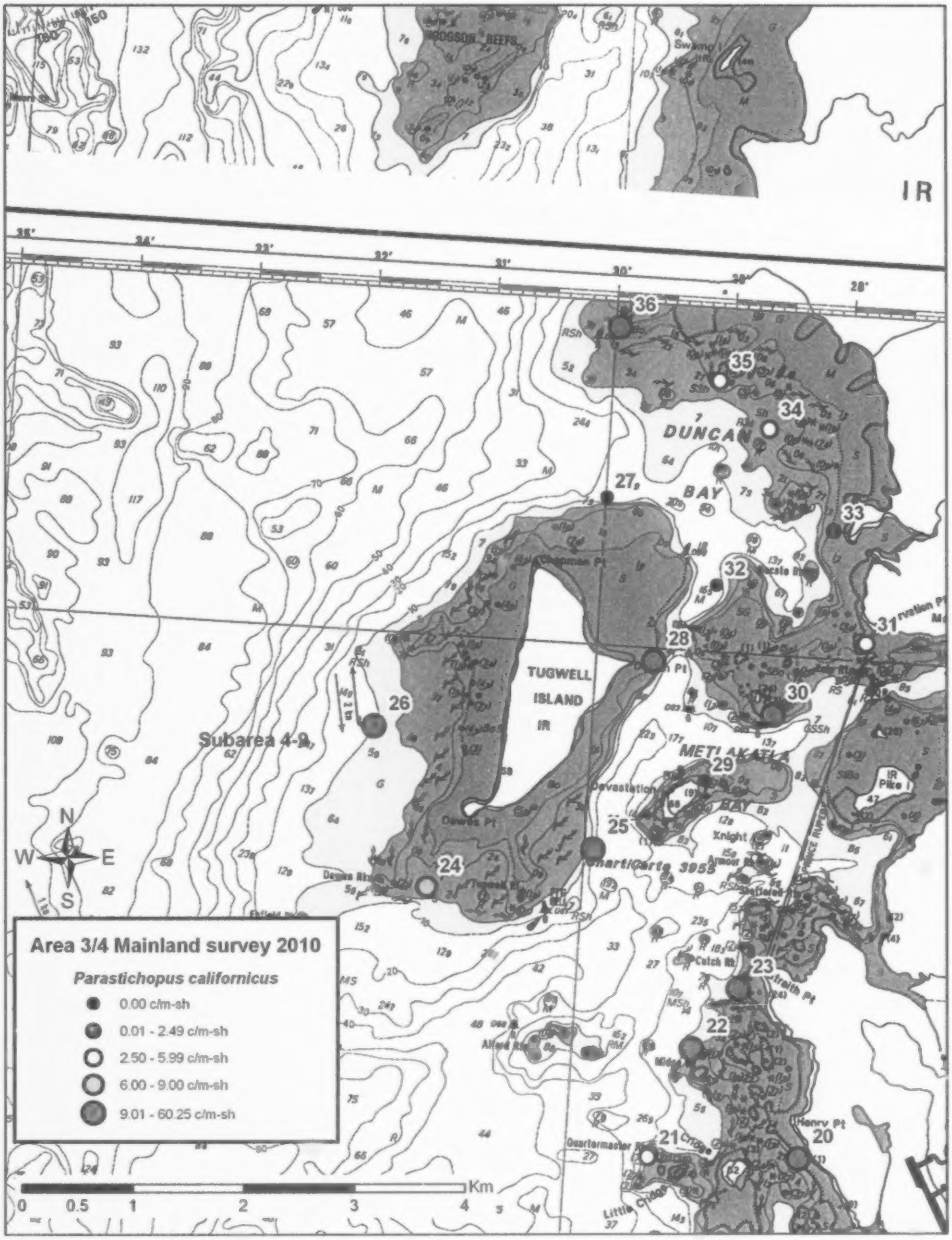

Area 3/4 Mainland survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
○ 6.00 - 9.00 c/m-sh
● 9.01 - 60.25 c/m-sh
DODGSON REEFS
IR
DUNCAN
BAY
TUGWELL
ISLAND
IR
Subarea 4-9
METLAKATLA
BAY
Chapman Pt
Dawes Pt
Knight
Pike I
Henry Pt
Quartermaster
N
S
E
W
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
0
0.5
1
2
3
4
Km

Figure 18a. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 4–9, surveyed as part of the Area 3/4 Mainland survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

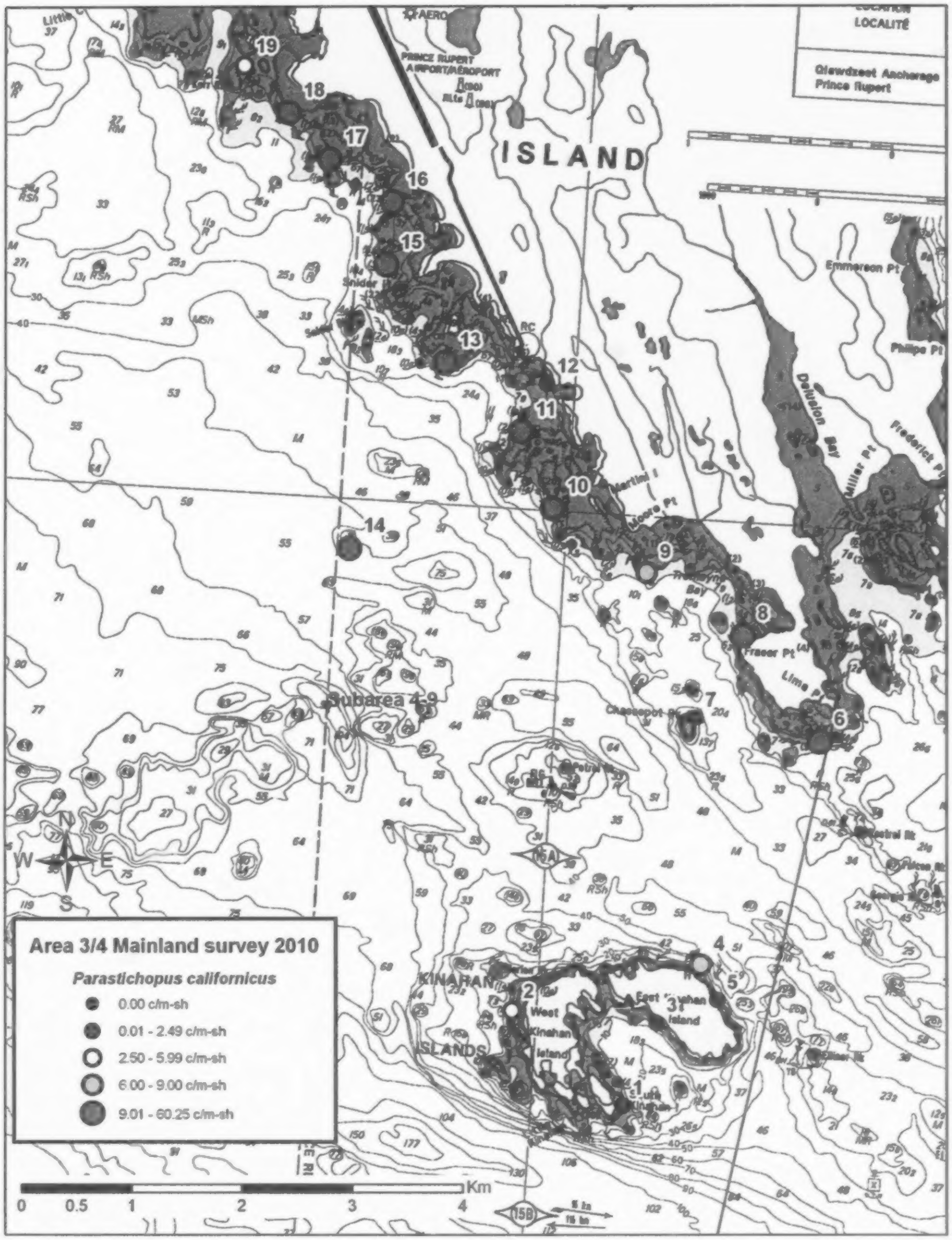

Area 3/4 Mainland survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 9.00 c/m-sh
9.01 - 60.25 c/m-sh
ISLAND
Subarea 4-9
KINAHAN ISLANDS
West Kinahan Island
East Kinahan Island
PRINCE RUPERT AIRPORT/AÉROPORT
LOCALITÉ
Olewdzeet Anchorage Prince Rupert
Emmerson Pt
Philips Pt
Dellulion Bay
Frederick Pt
Fraser Pt
Lime Pt
Chasepot
Martini I
Moore Pt
Tremayne Bay
Snider
N
S
W
E
0
0.5
1
2
3
4
Km
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

Figure 18b. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 4–9, surveyed as part of the Area 3/4 Mainland survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

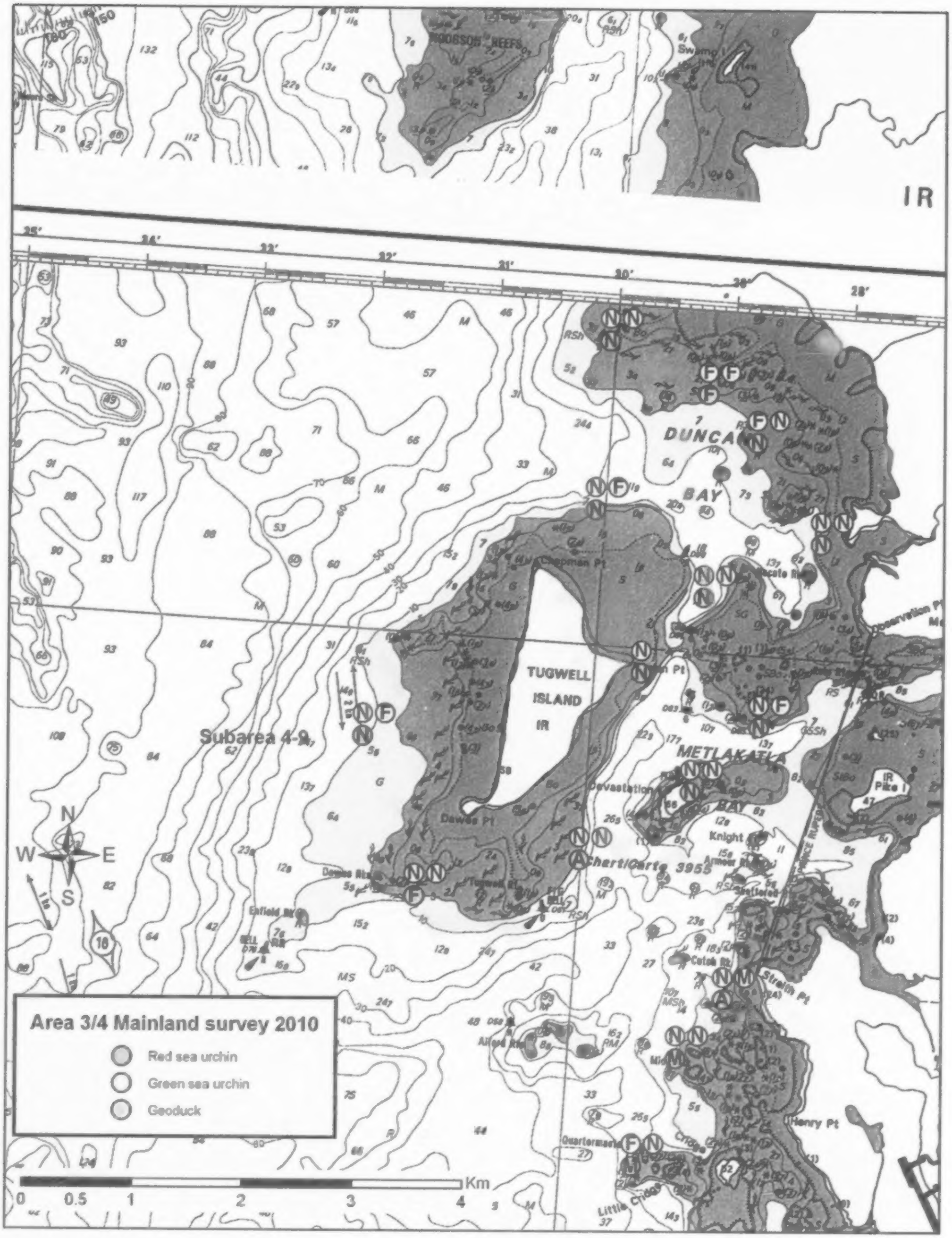

HODGSON REEFS
IR
DUNCAN BAY
TUGWELL ISLAND IR
METLAKATLA BAY
Subarea 4-9
N
W
E
S
Area 3/4 Mainland survey 2010
Red sea urchin
Green sea urchin
Geoduck
0
0.5
1
2
3
4
Km

Figure 19a. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 4–9. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

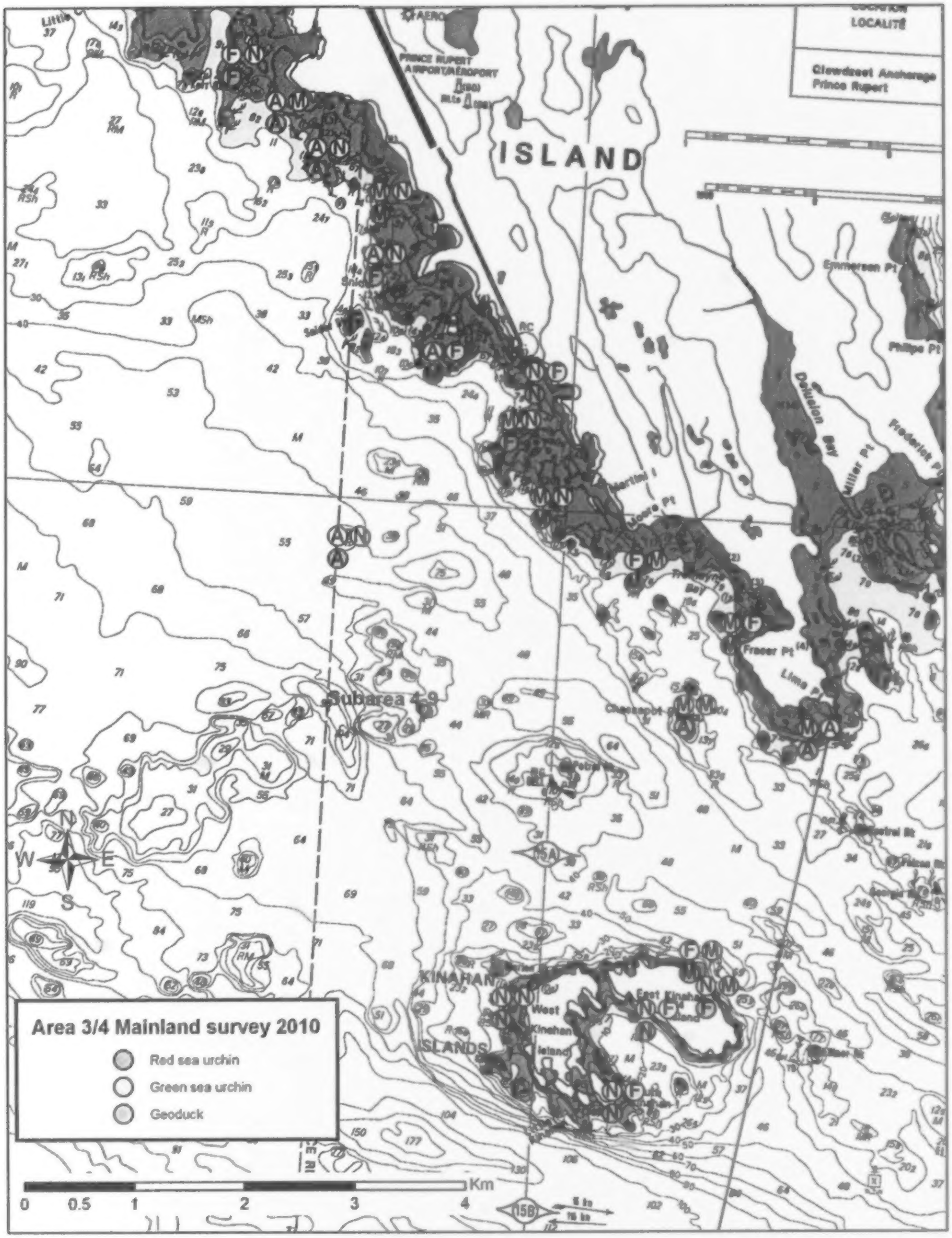

LOCALITÉ
ISLAND
Emmerson Pt
Philips Pt
Delusion Bay
Frederick Pt
Miller Pt
Moore Pt
Fraser Pt
Lima Pt
Subarea 4-9
KINAHAN ISLANDS
West Kinahan Island
East Kinahan Island
N
S
W
E
Area 3/4 Mainland survey 2010
Red sea urchin
Green sea urchin
Geoduck
0
0.5
1
2
3
4
Km
15A
15B

Figure 19b. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 4–9. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

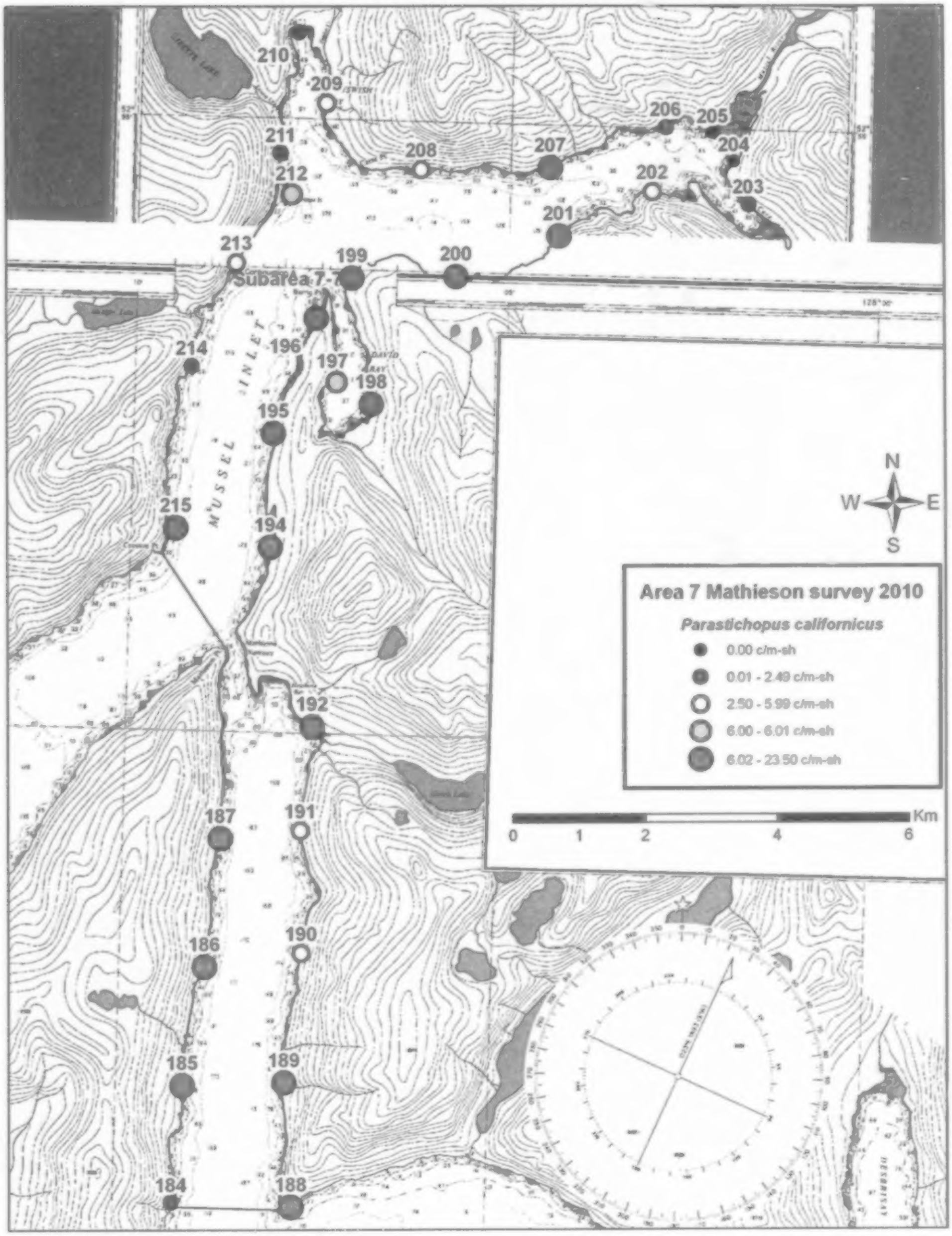

210
209
211
212
208
207
206
205
204
202
203
201
213
199
200
Subarea 7-7
196
197
198
214
195
215
194
192
187
191
186
190
185
189
184
188
N
W
E
S
Area 7 Mathieson survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 6.01 c/m-sh
6.02 - 23.50 c/m-sh
Km
0
1
2
4
6
M'USSEL
INLET

Figure 20. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 7–7, surveyed as part of the Area 7 Mathieson survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

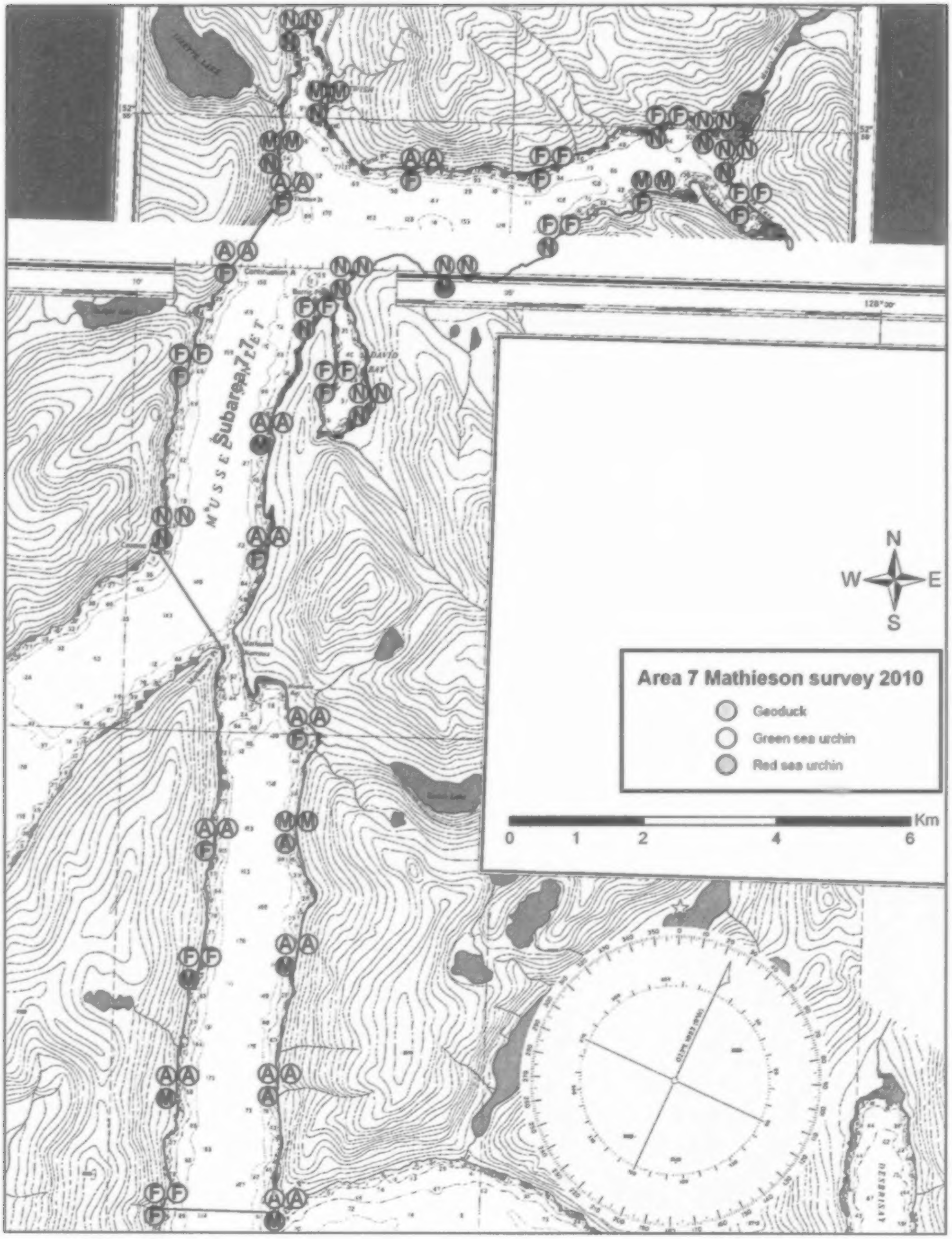

Subarea 7-7
Area 7 Mathieson survey 2010
Geoduck
Green sea urchin
Red sea urchin
N
W
E
S
Km
0
1
2
4
6

Figure 21. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 7–7. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

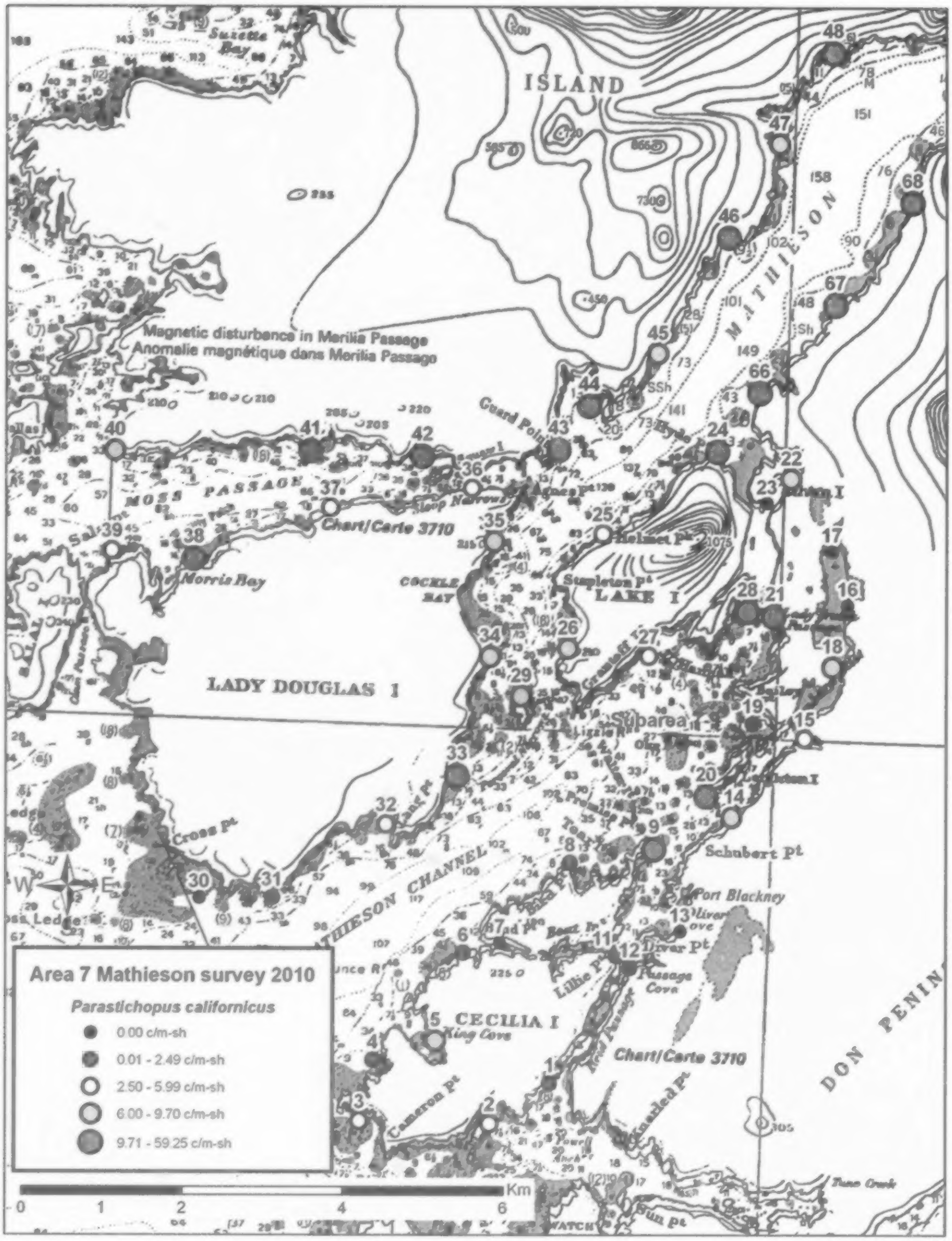

Area 7 Mathieson survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 9.70 c/m-sh
9.71 - 59.25 c/m-sh
Km
0
1
2
4
6
ISLAND
MATHIESON
Magnetic disturbance in Meriila Passage
Anomalie magnétique dans Meriila Passage
MOSS PASSAGE
Chart/Carte 3710
Morris Bay
COCKLE BAY
LADY DOUGLAS I
LAKE I
Helmet Pt
Stapleton Pt
Guard Point
Subarea
Schubert Pt
Port Blackney
Diver Pt
Passage Cove
Lillie Pt
CECILIA I
King Cove
Cameron Pt
Cross Pt
MATHIESON CHANNEL
DON PENIN
Chart/Carte 3710
1
2
3
4
5
6
7
8
9
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
66
67
68

Figure 22a. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 7–9, surveyed as part of the Area 7 Mathieson survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

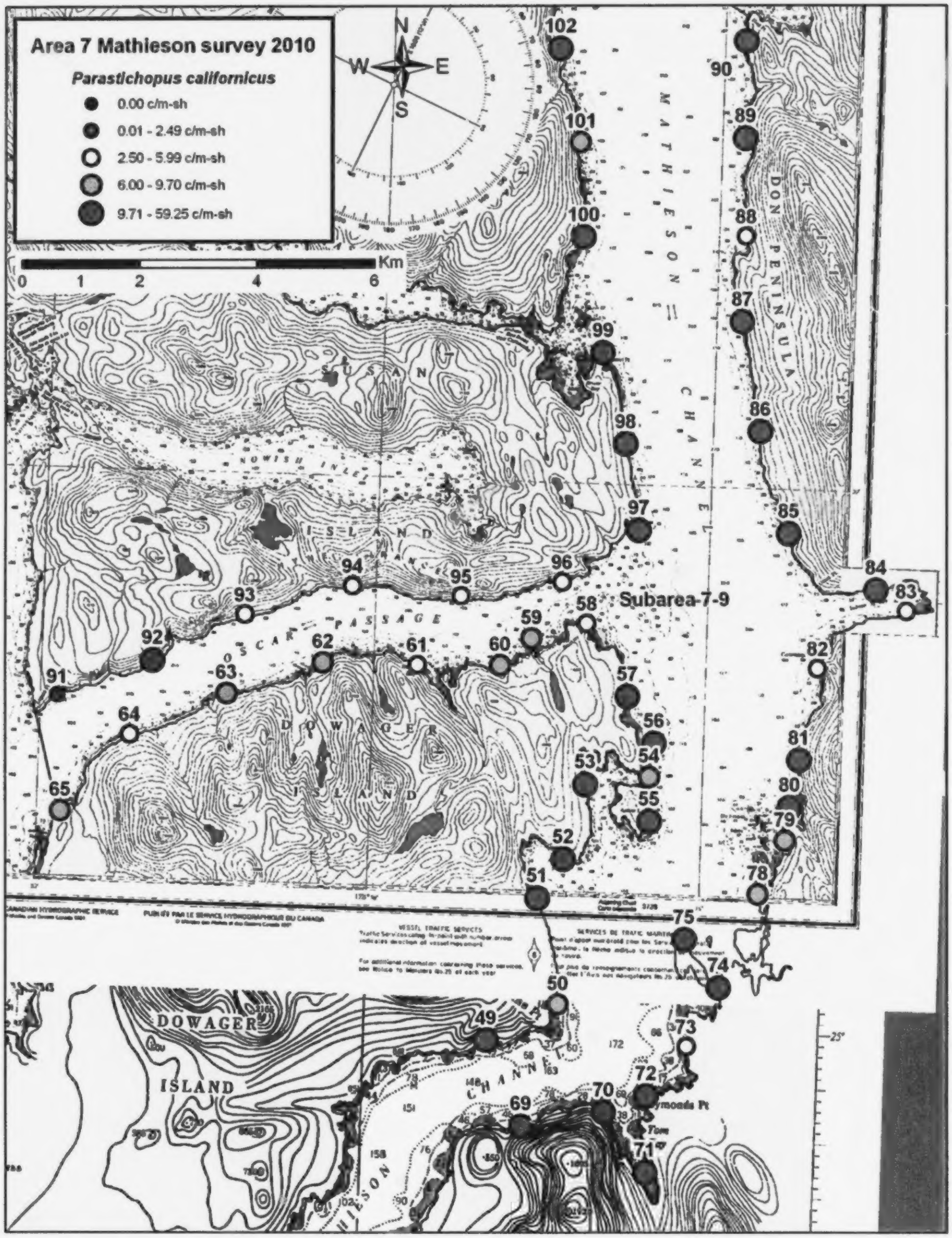

Area 7 Mathieson survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 9.70 c/m-sh
● 9.71 - 59.25 c/m-sh
Km
0 1 2 4 6
N
W
E
S
Subarea-7-9
MATHIESON CHANNEL
DON PENINSULA
SUSAN ISLAND
DOWAGER ISLAND
OSCAR PASSAGE
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
79
78
75
74
73
72
71
70
69
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49

Figure 22b. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 7–9, surveyed as part of the Area 7 Mathieson survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

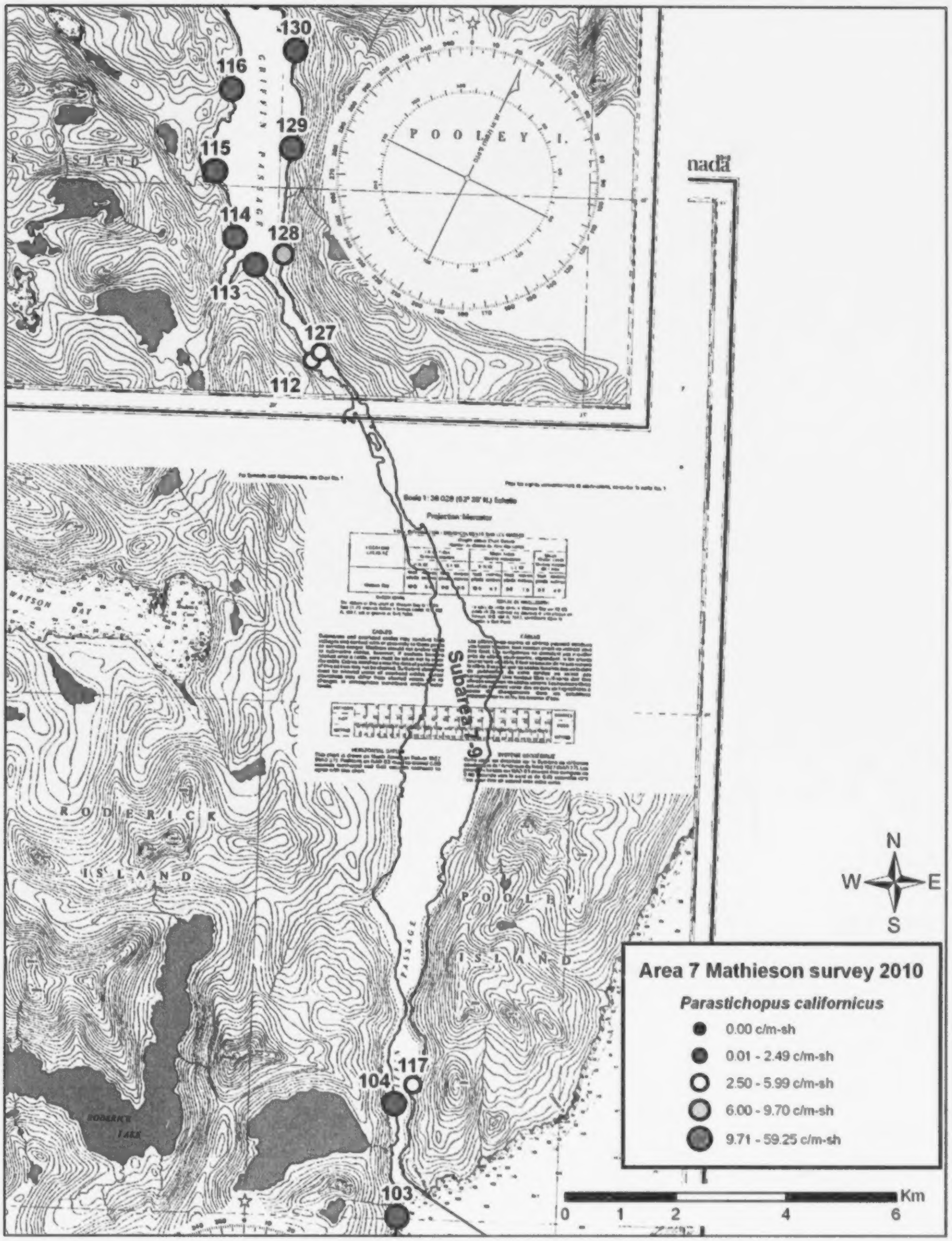

130
116
129
115
114
128
113
127
112
GRIFFIN PASSAGE
POOLEY I.
ISLAND
nada
WATSON BAY
Subarea 7-9
RODERICK ISLAND
POOLEY ISLAND
PASSAGE
RODERICK LAKE
117
104
103
N
W
E
S
Area 7 Mathieson survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 9.70 c/m-sh
● 9.71 - 59.25 c/m-sh
0
1
2
4
6
Km

Figure 22c. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in a portion of PFMA Subarea 7–9, surveyed as part of the Area 7 Mathieson survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

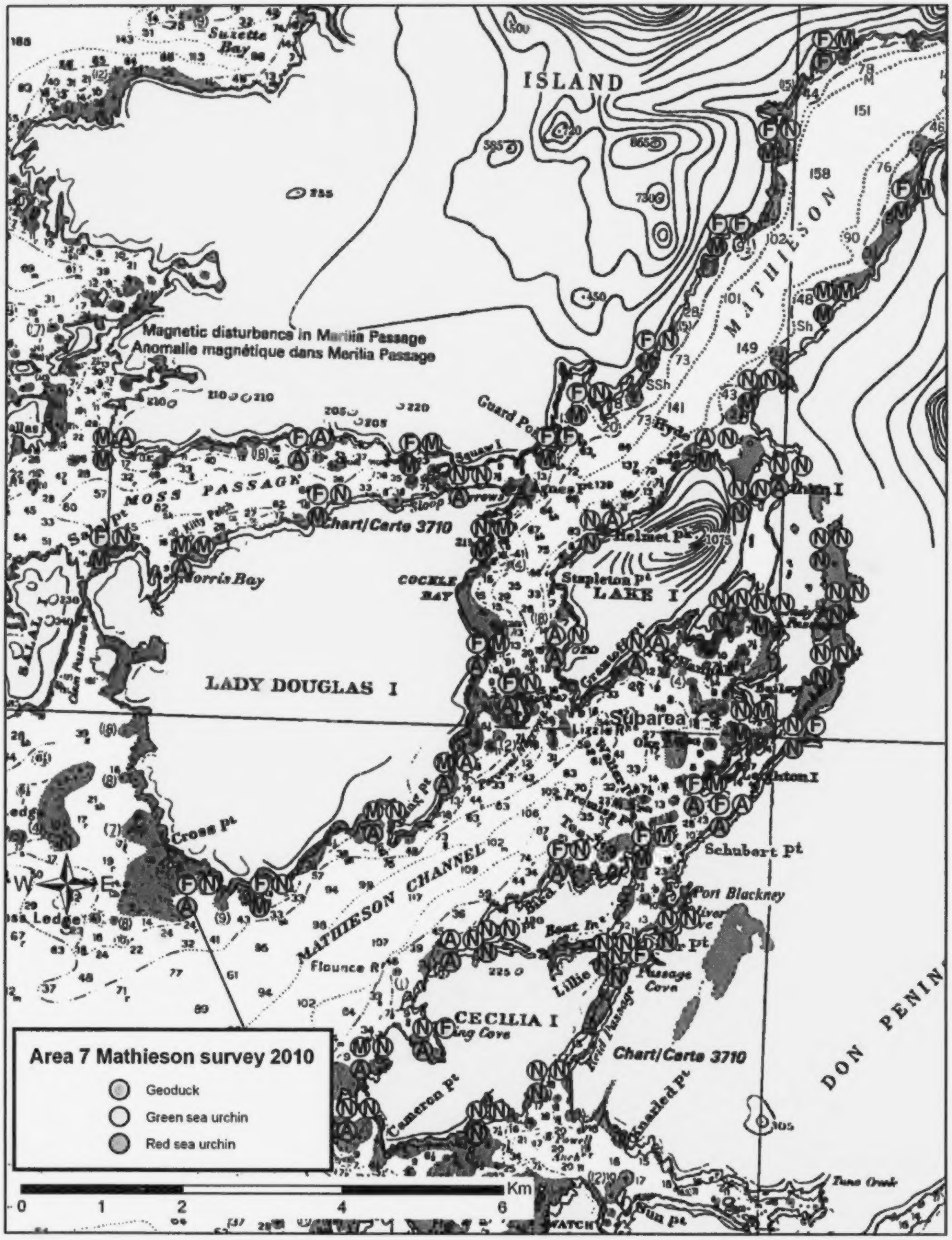

Area 7 Mathieson survey 2010
Geoduck
Green sea urchin
Red sea urchin
Km
0
1
2
4
6
W
E
ISLAND
Suzette Bay
Magnetic disturbance in Meriila Passage
Anomalie magnétique dans Meriila Passage
MOSS PASSAGE
Chart/Carte 3710
Morris Bay
COCKLE BAY
LADY DOUGLAS I
Stapleton Pt
LAKE I
Helmet Pt
Guard Pt
Subarea 7-9
MATHIESON CHANNEL
MATHIESON
Cross Pt
Schubert Pt
Port Blackney
Flounce Rk
CECILIA I
Lillie
Passage Cove
Chart/Carte 3710
Cameron Pt
DON PENINSULA
Pelter Pt

Figure 23a. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in a portion of PFMA Subarea 7–9. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

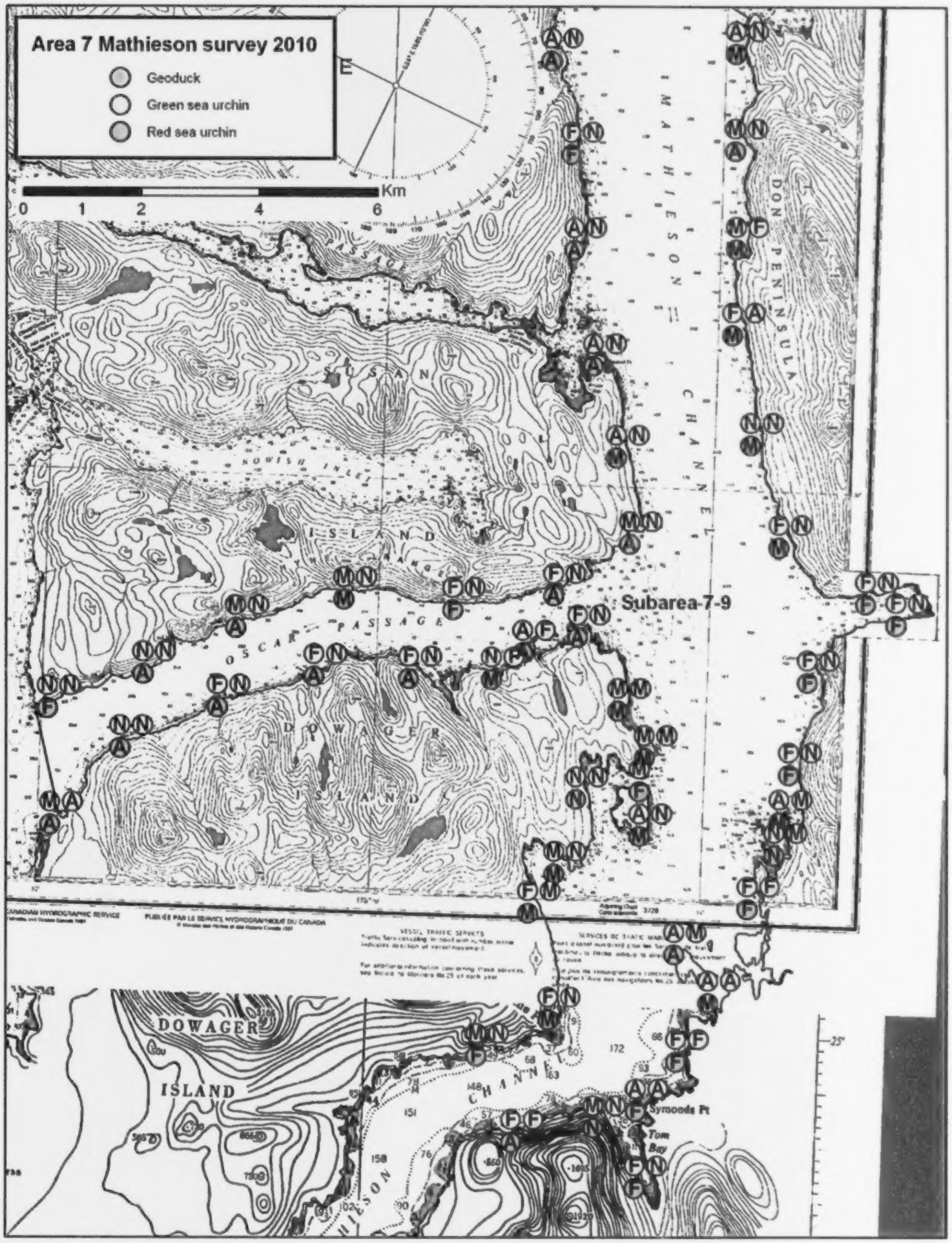

Area 7 Mathieson survey 2010
○ Geoduck
○ Green sea urchin
○ Red sea urchin
Km
0
1
2
4
6
Subarea 7-9
MATHIESON CHANNEL
DON PENINSULA
SUSAN ISLAND
NOWISH INLET
OSCAR PASSAGE
DOWAGER ISLAND
Symonds Pt
Tom Bay

Figure 23b. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in a portion of PFMA Subarea 7–9. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

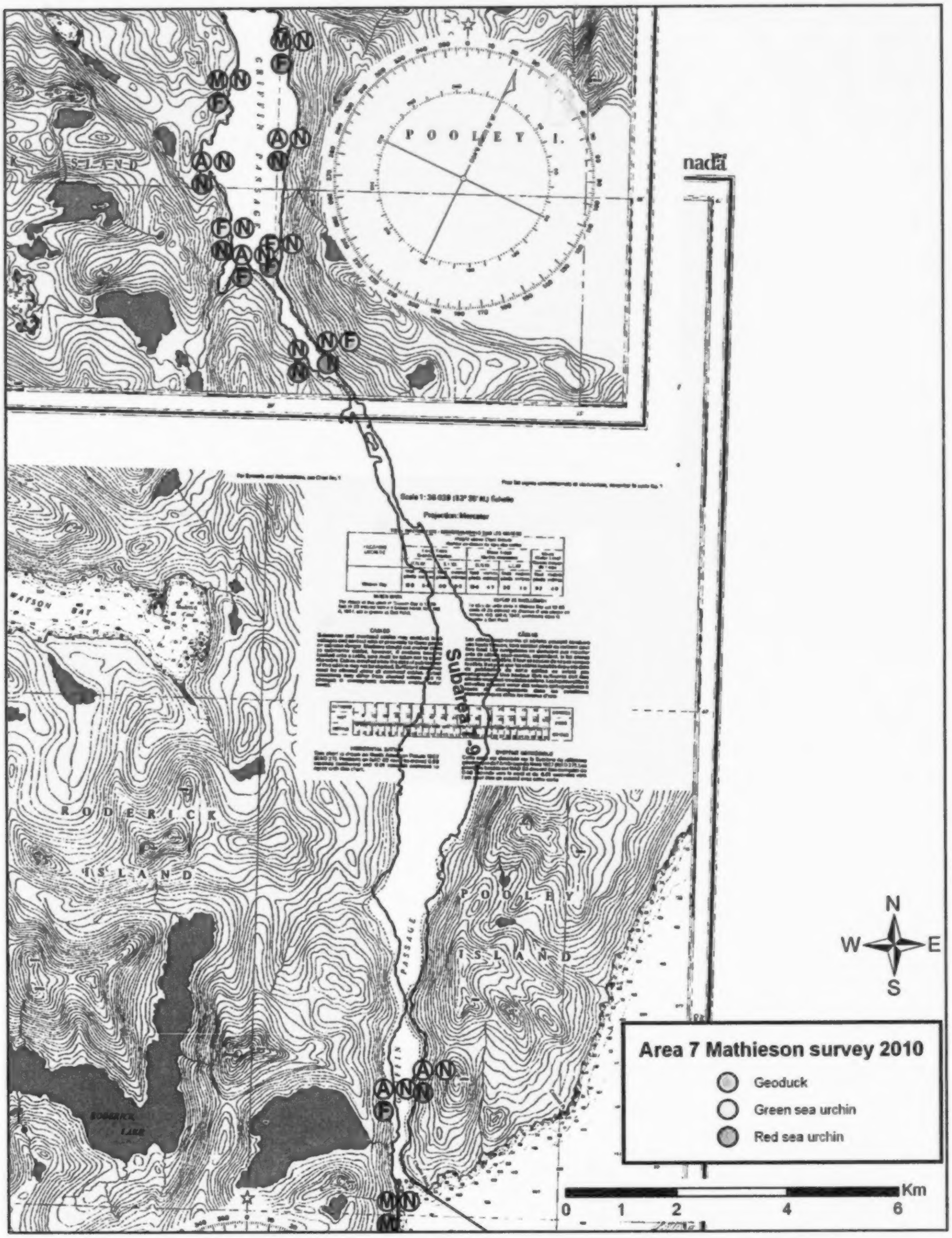

Area 7 Mathieson survey 2010
Geoduck
Green sea urchin
Red sea urchin
N
W
E
S
Km
0
1
2
4
6
Subarea 7-9
POOLEY I.
RODERICK ISLAND
POOLEY ISLAND
GRIFFIN PASSAGE
WATSON BAY
RODERICK LAKE
nada
A
M
F
N

Figure 23c. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in a portion of PFMA Subarea 7–9. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

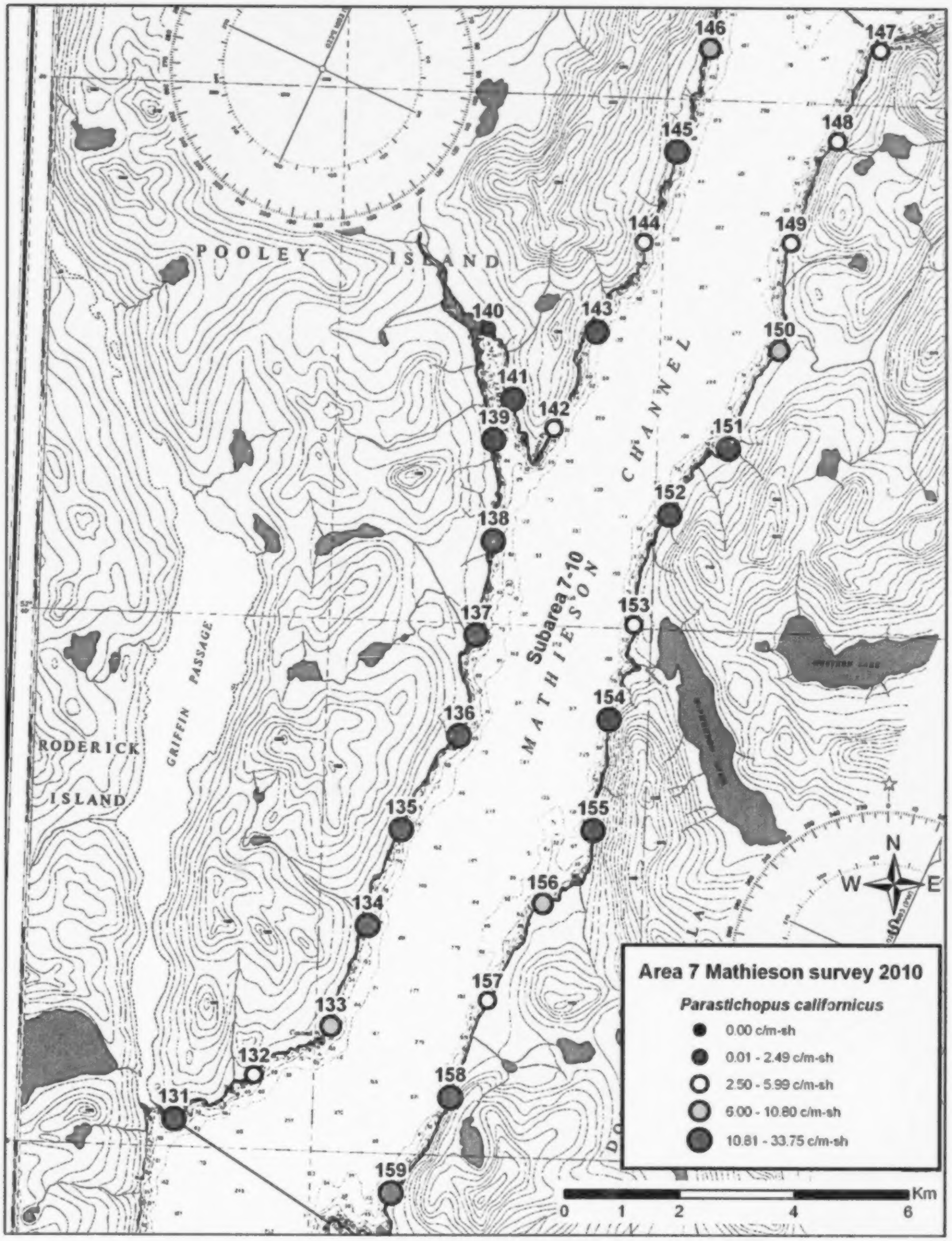

146
147
145
148
144
149
POOLEY ISLAND
140
143
150
141
139
142
151
152
138
MATHIESON CHANNEL
Subarea 7-10
137
153
GRIFFIN PASSAGE
154
136
RODERICK ISLAND
135
155
N
W
E
S
156
134
157
133
132
158
131
159
Area 7 Mathieson survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.99 c/m-sh
6.00 - 10.80 c/m-sh
10.81 - 33.75 c/m-sh
Km
0
1
2
4
6

Figure 24. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 7–10, surveyed as part of the Area 7 Mathieson survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

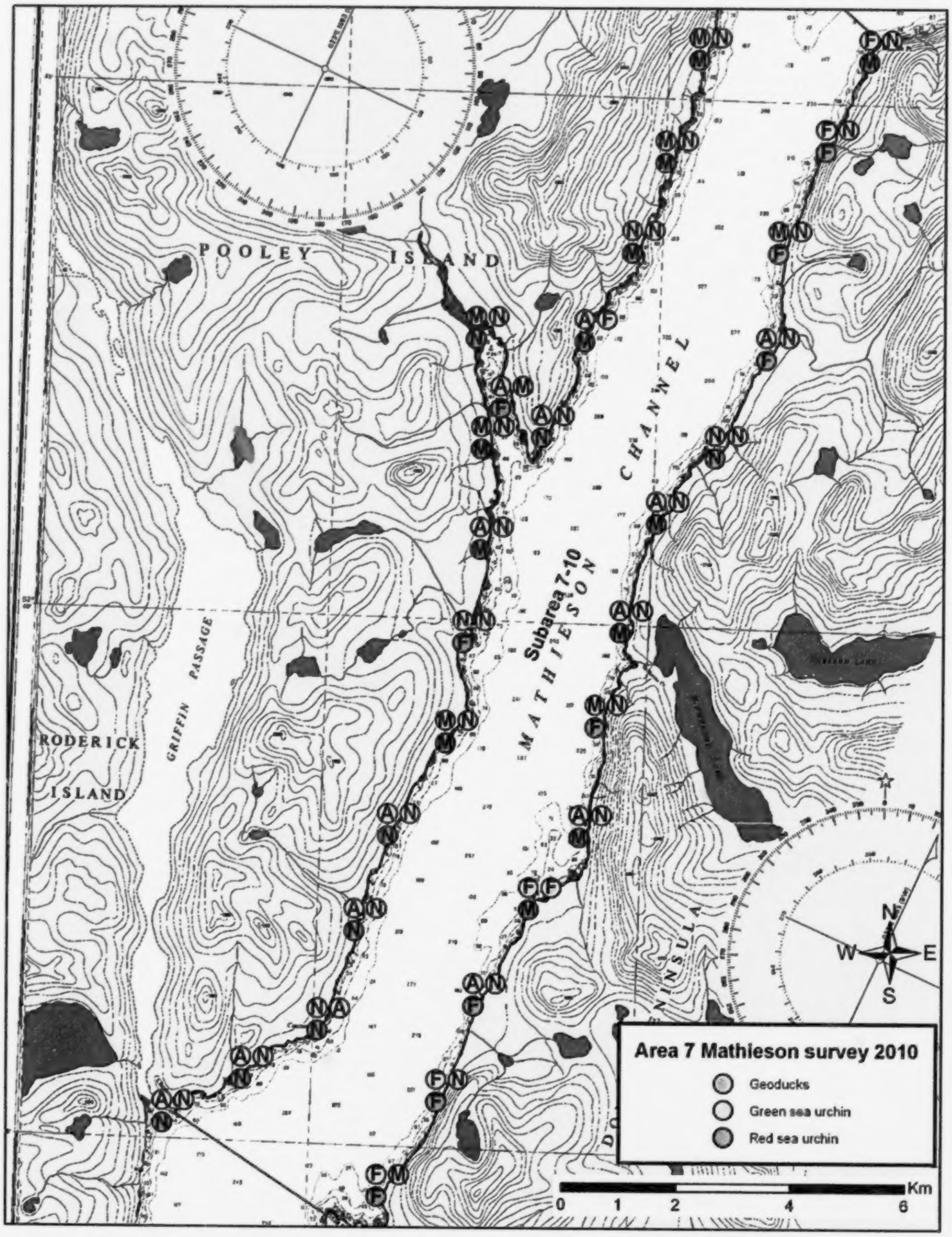

POOLEY ISLAND
RODERICK ISLAND
GRIFFIN PASSAGE
MATHIESON CHANNEL
Subarea 7-10
M N M
M N M
F N M
F N F
N N M
M N F
M N N
A F M
A M F
A N N
A N F
M N M
N N N
A N M
A N M
A N M
N N F
M N F
M N M
A N N
A N M
A N N
F F M
N A N
A N F
A N N
A N N
F N F
F M F
Area 7 Mathieson survey 2010
Geoducks
Green sea urchin
Red sea urchin
N
W
E
S
0
1
2
4
6
Km

Figure 25. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 7–10. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

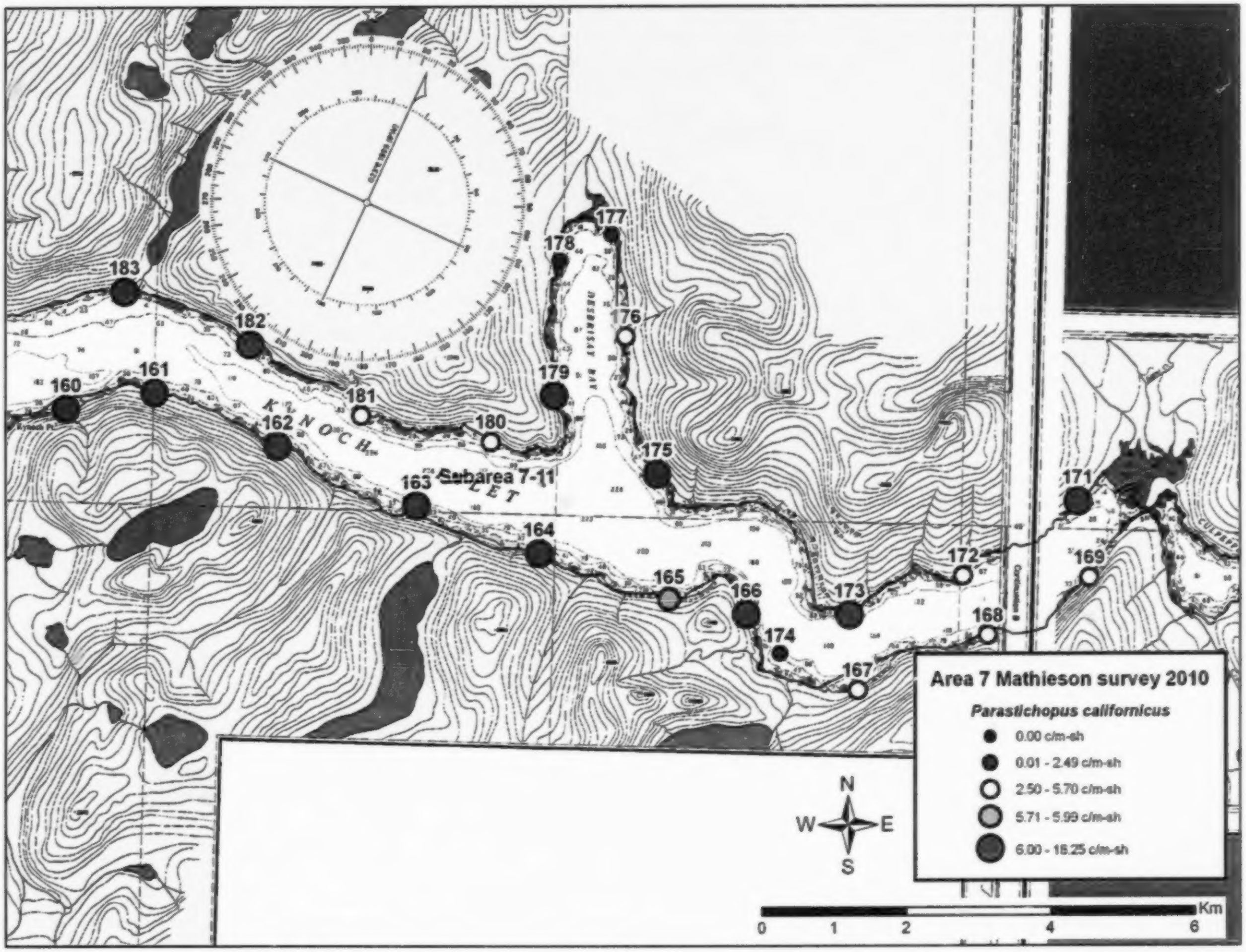

183
182
161
160
162
181
180
179
178
177
176
175
163
Subarea 7-11
164
165
166
174
173
167
172
168
171
169
N
W
E
S
Area 7 Mathieson survey 2010
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 5.70 c/m-sh
5.71 - 5.99 c/m-sh
6.00 - 18.25 c/m-sh
0
1
2
4
6
Km

Figure 26. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 7–11, surveyed as part of the Area 7 Mathieson survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and the bootstrapped 90% lower confidence bound calculated for the Subarea, 5.70 c/m-sh); green = productive locations (between 5.71 c/m-sh and the baseline regional density for the North Coast); blue = very productive locations (densities above the baseline regional density for the North Coast).

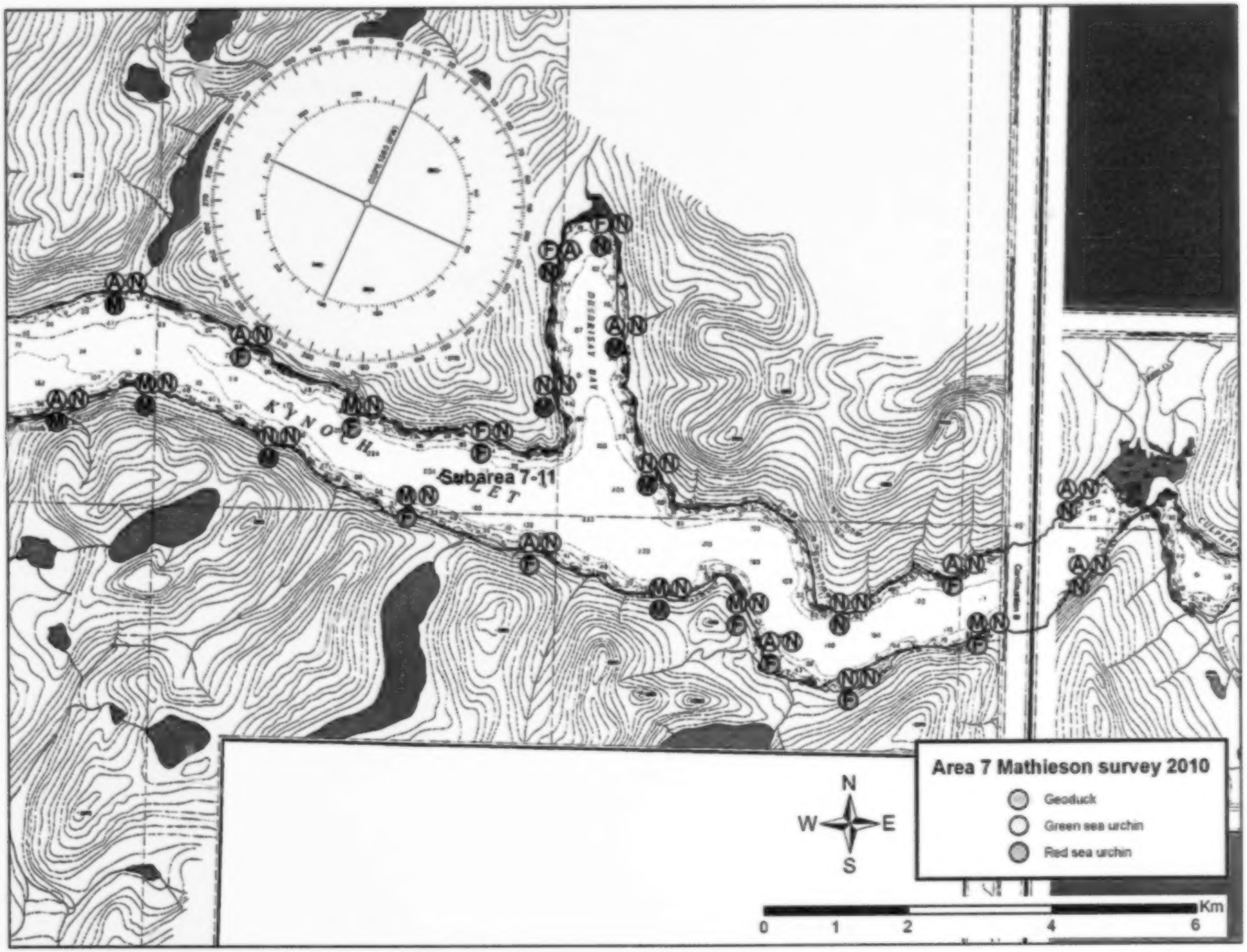

Subarea 7-11
Area 7 Mathieson survey 2010
Geoduck
Green sea urchin
Red sea urchin
N
W
E
S
0
1
2
4
6
Km

Figure 27. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 7–11. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

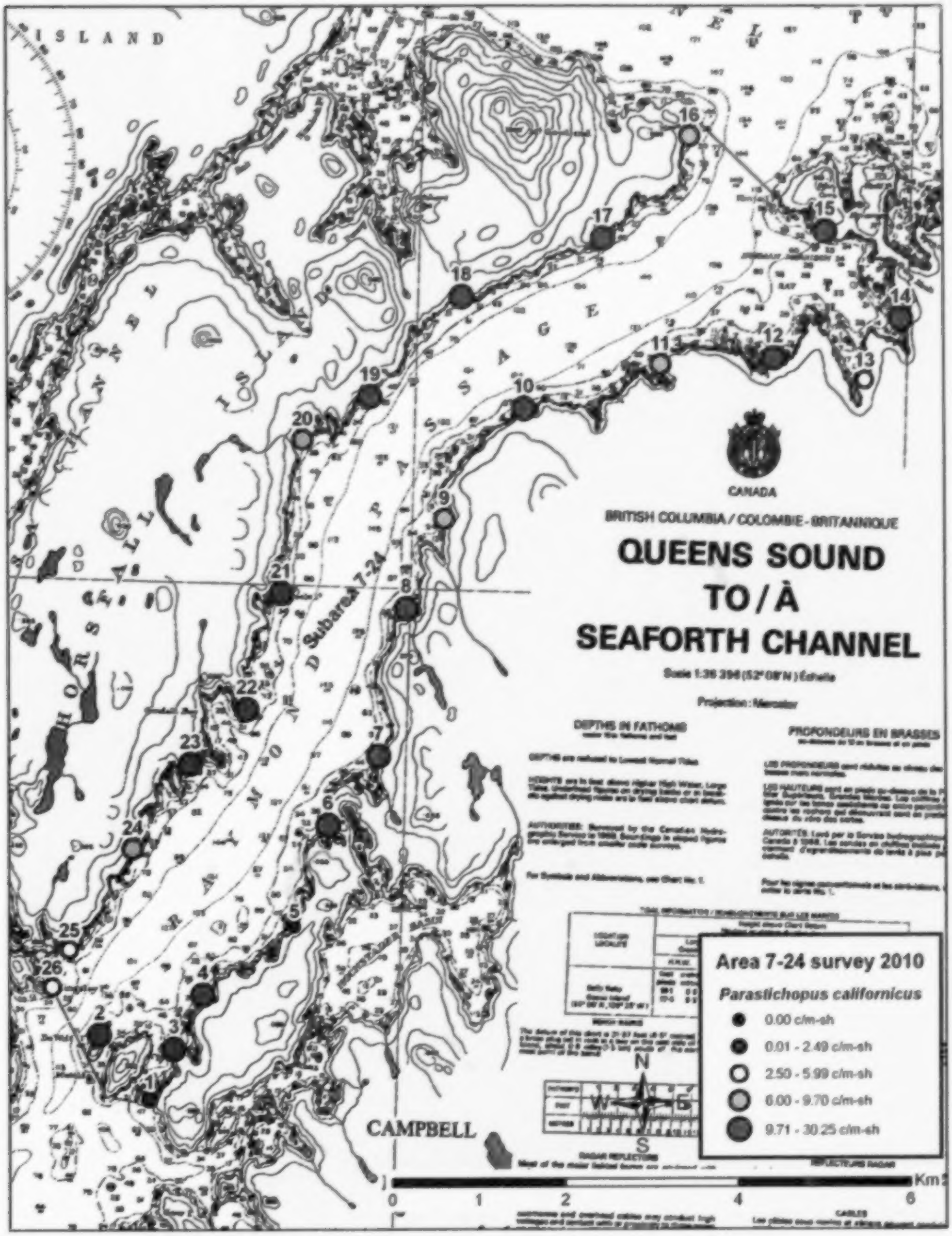

ISLAND
QUEENS SOUND
TO / À
SEAFORTH CHANNEL
CANADA
BRITISH COLUMBIA / COLOMBIE-BRITANNIQUE
Subarea 7-24
CAMPBELL
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
Area 7-24 survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 9.70 c/m-sh
● 9.71 - 30.25 c/m-sh
N
S
W
E
0
1
2
4
6
Km

Figure 28. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 7–24 surveyed in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

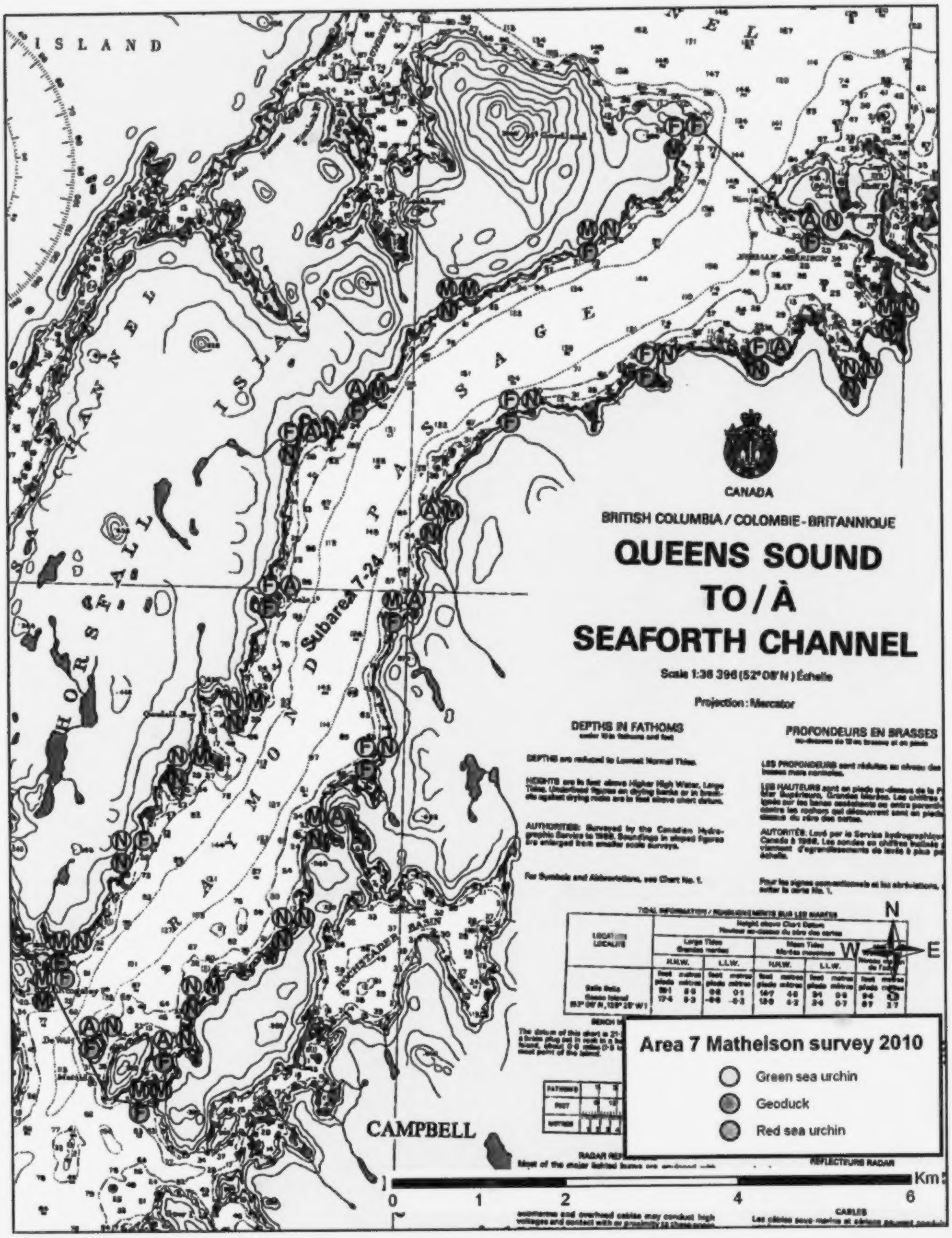

ISLAND
CANADA
BRITISH COLUMBIA / COLOMBIE-BRITANNIQUE
QUEENS SOUND TO / À SEAFORTH CHANNEL
Projection : Mercator
DEPTHS IN FATHOMS
PROFONDEURS EN BRASSES
Subarea 7-24
CAMPBELL
N
W
E
Area 7 Matheison survey 2010
Green sea urchin
Geoduck
Red sea urchin
Km
0
1
2
4
6

Figure 29. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 7–24. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

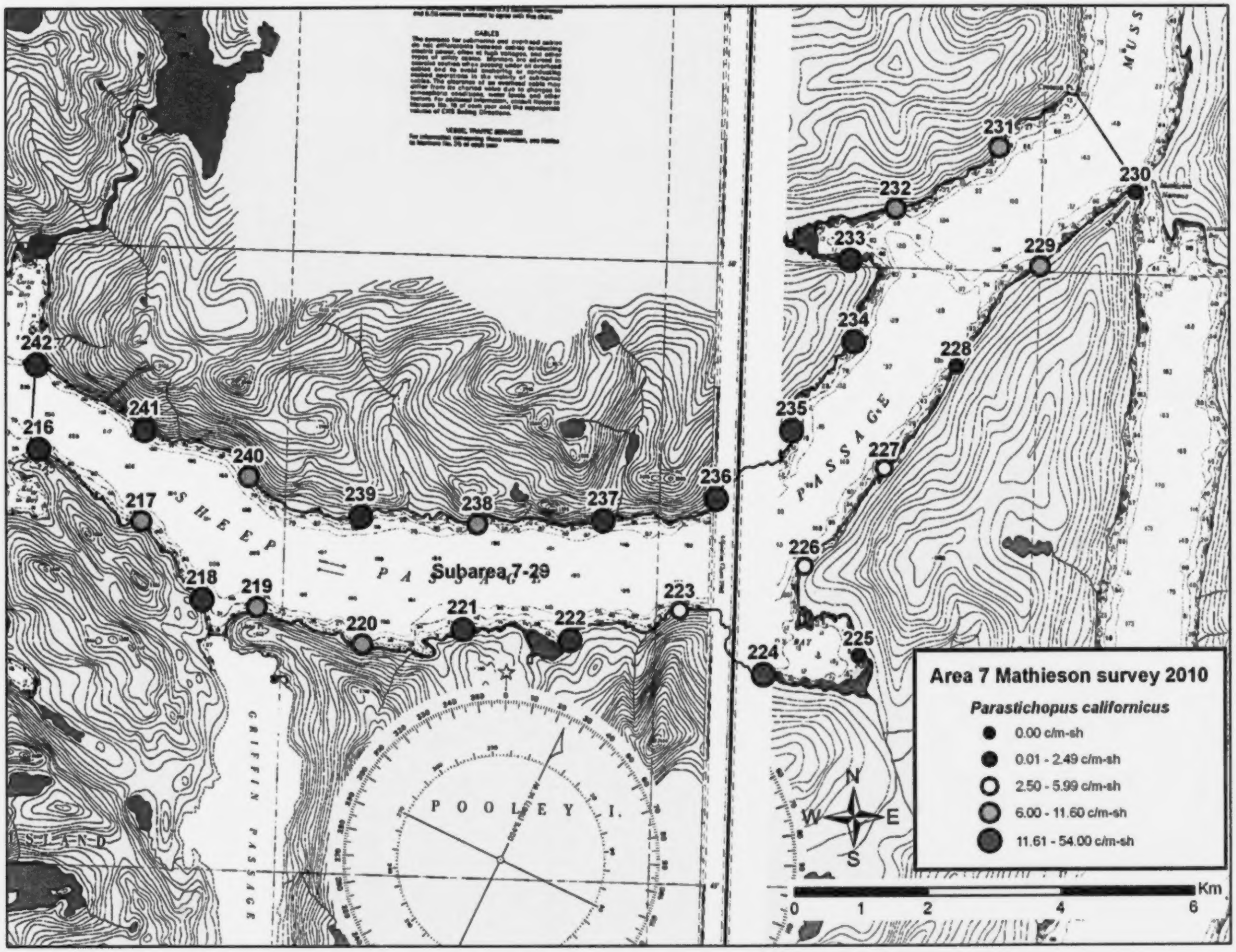

Area 7 Mathieson survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.99 c/m-sh
● 6.00 - 11.60 c/m-sh
● 11.61 - 54.00 c/m-sh
Subarea 7-29
SHEEP PASSAGE
PASSAGE
GRIFFIN PASSAGE
POOLEY I.
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
N
E
S
W
0
1
2
4
6
Km

Figure 30. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 7–29, surveyed as part of the Area 7 Mathieson survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 5.99 c/m-sh); green = productive locations (between 6.00 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

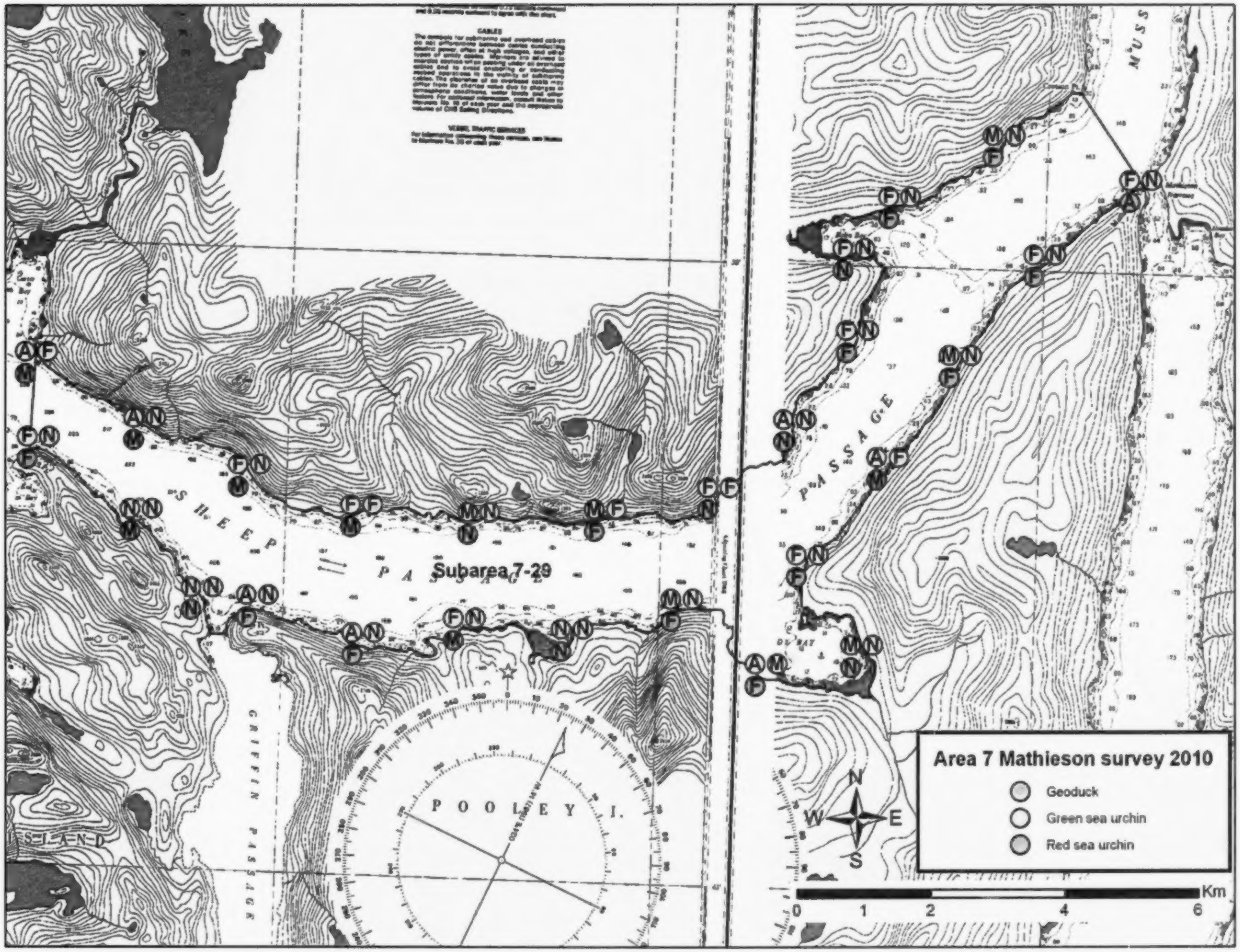

Area 7 Mathieson survey 2010
Geoduck
Green sea urchin
Red sea urchin
Subarea 7-29
SHEEP PASSAGE
PASSAGE
GRIFFIN PASSAGE
POOLEY I.
ISLAND
MUSS
N
S
E
W
0
1
2
4
6
Km

Figure 31. Relative abundance of red sea urchin, green sea urchin and geoduck on transects surveyed for sea cucumber in PFMA Subarea 7–29. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); N=zero animals.

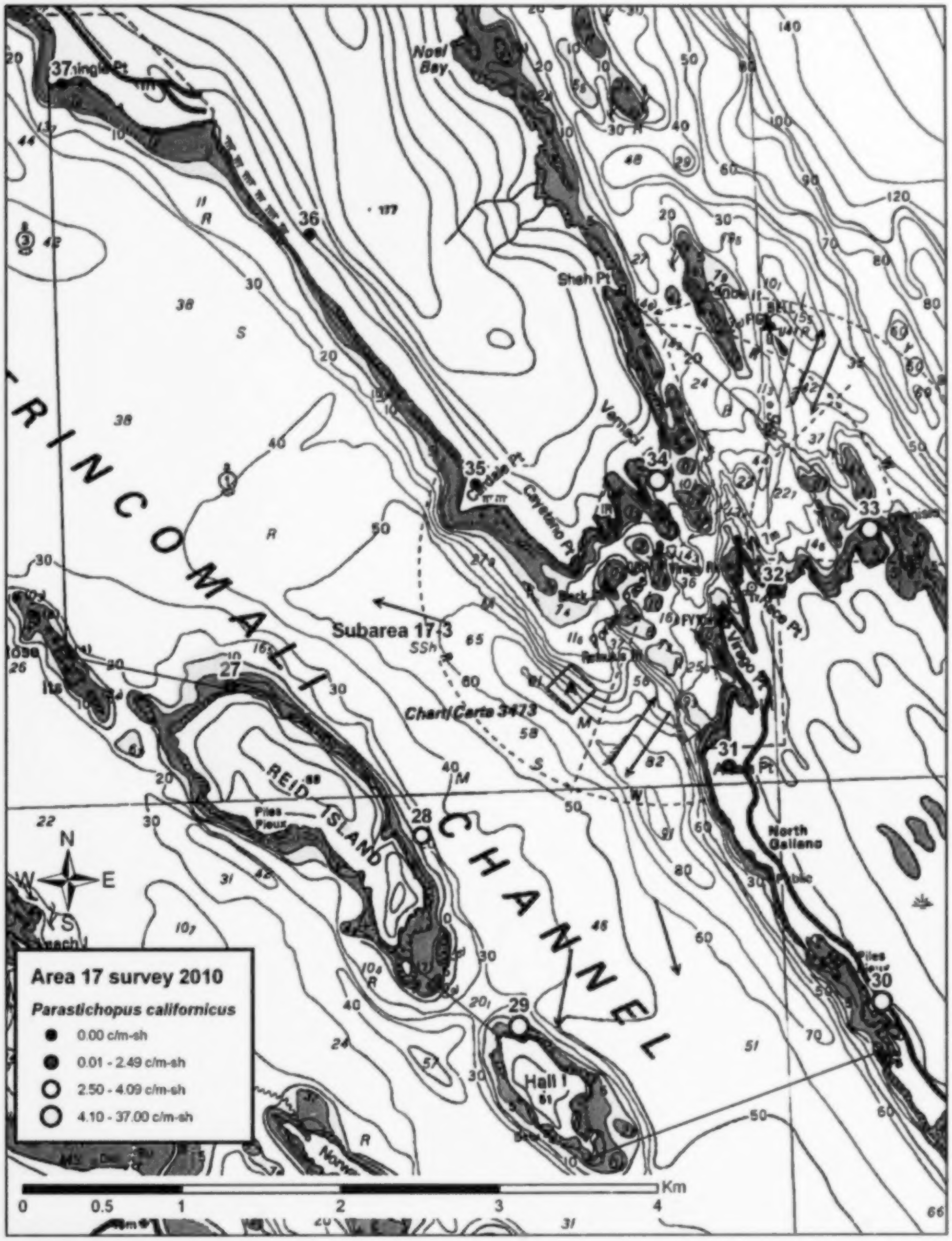

Area 17 survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
○ 4.10 - 37.00 c/m-sh
TRINCOMALI CHANNEL
REID ISLAND
Subarea 17-3
Chart/Carte 3473
Noel Bay
North Galiano
Hall I
N
E
S
W
27
28
29
30
31
32
33
34
35
36
37
0
0.5
1
2
3
4
Km

Figure 32. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 17–3, surveyed as part of the Area 17 survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and the baseline regional density for the East Coast Vancouver Island); and green = productive locations (between 4.10 c/m-sh and the maximum observed in the Subarea).

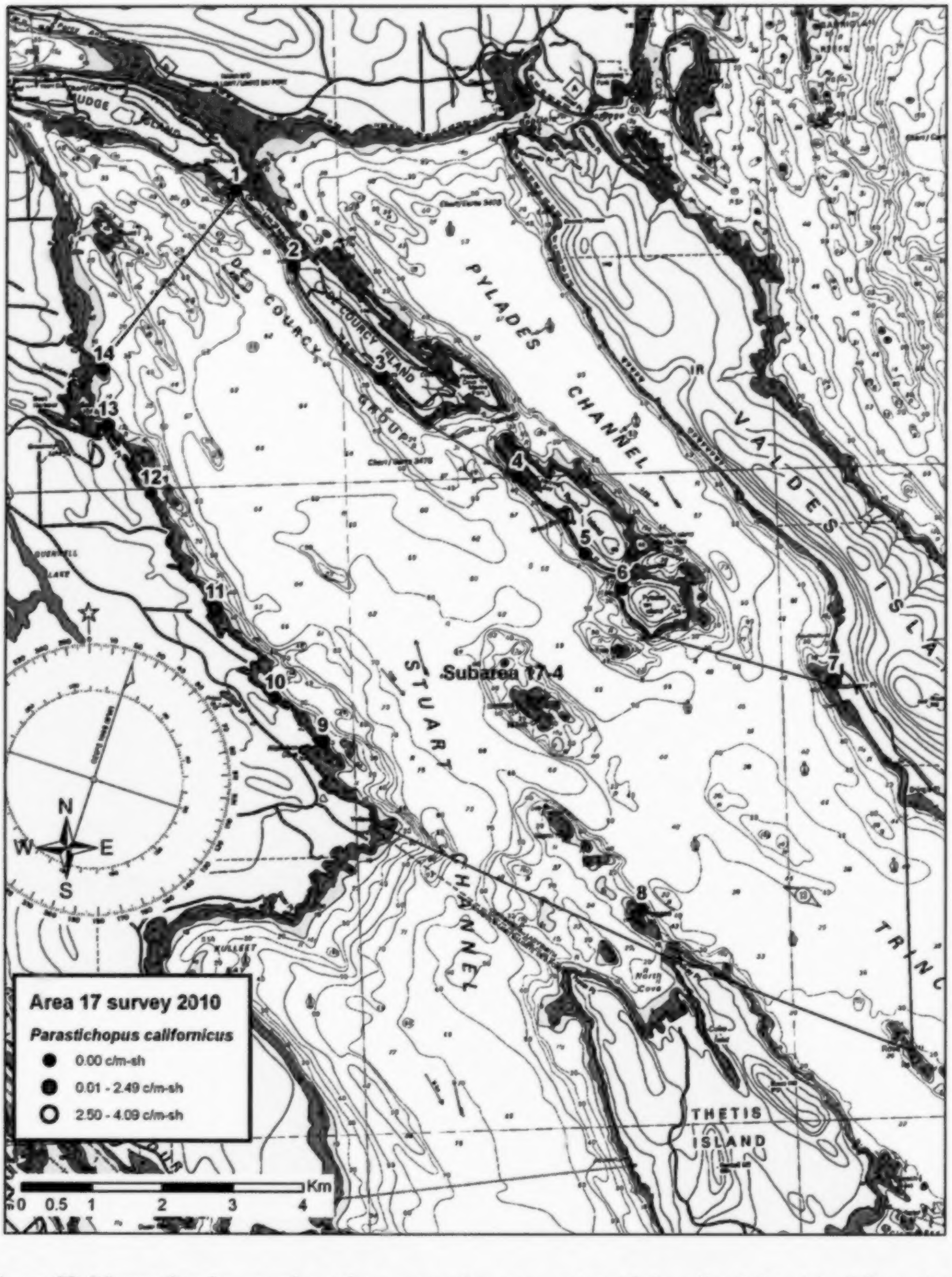

Area 17 survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
DE COURCY GROUP
DE COURCY ISLAND
PYLADES CHANNEL
VALDES ISLA
STUART CHANNEL
Subarea 17-4
THETIS ISLAND
North Cove
TRINC
1
2
3
4
5
6
7
8
9
10
11
12
13
14
N
W
E
S
Km
0 0.5 1 2 3 4

Figure 33. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 17–4, surveyed as part of the Area 17 survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); and yellow = medium density (between 2.5 and the baseline regional density for the East Coast Vancouver Island).

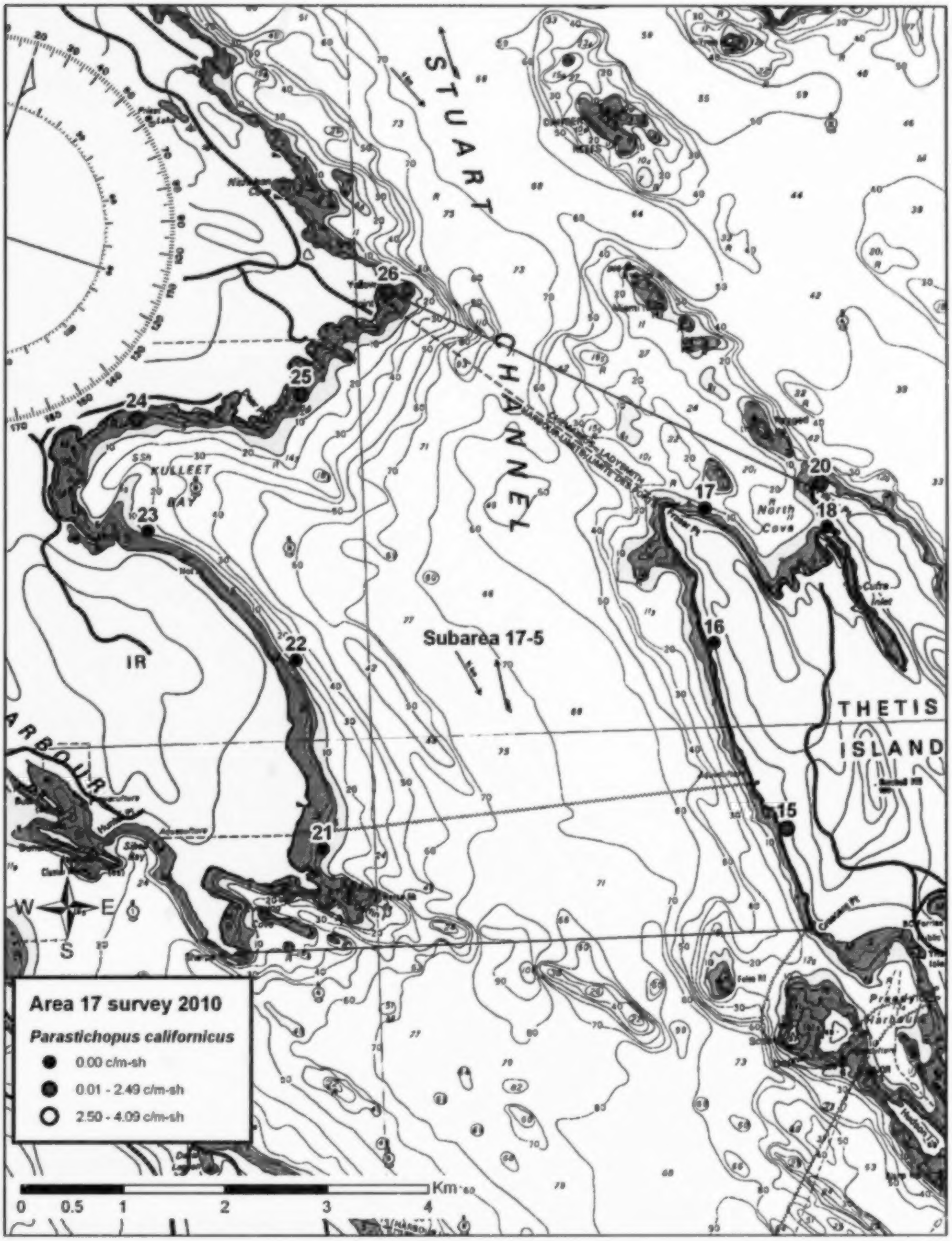

STUART CHANNEL
Subarea 17-5
THETIS ISLAND
KULLEET BAY
North Cove
IR
HARBOUR
26
25
24
23
22
21
20
18
17
16
15
W
E
S
Area 17 survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
0
0.5
1
2
3
4
Km

Figure 34. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subarea 17–5, surveyed as part of the Area 17 survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); and yellow = medium density (between 2.5 and the baseline regional density for the East Coast Vancouver Island).

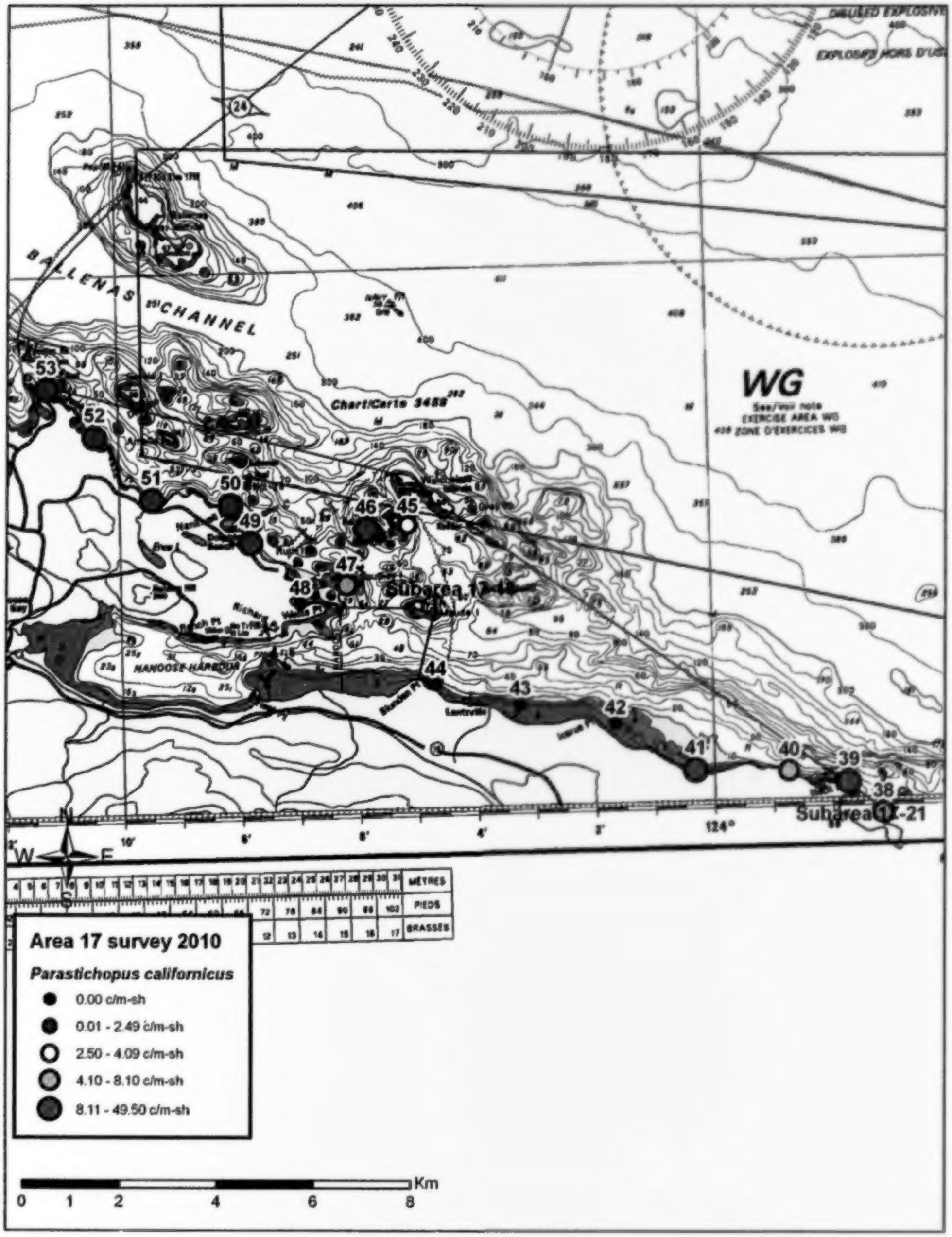

BALLENAS CHANNEL
WG
Chart/Carte 3459
NANOOSE HARBOUR
53
52
51
50
49
46
45
47
48
Subarea 17-18
44
43
42
41
40
39
38
Subarea 17-21
124°
N
W
E
S
MÈTRES
PIEDS
BRASSES
Area 17 survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
● 4.10 - 8.10 c/m-sh
● 8.11 - 49.50 c/m-sh
Km
0
1
2
4
6
8

Figure 35. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subareas 17–18 and 17–21, surveyed as part of the Area 17 survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and the baseline regional density for the East Coast Vancouver Island); green = productive locations (between 4.10 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound for the Subarea).

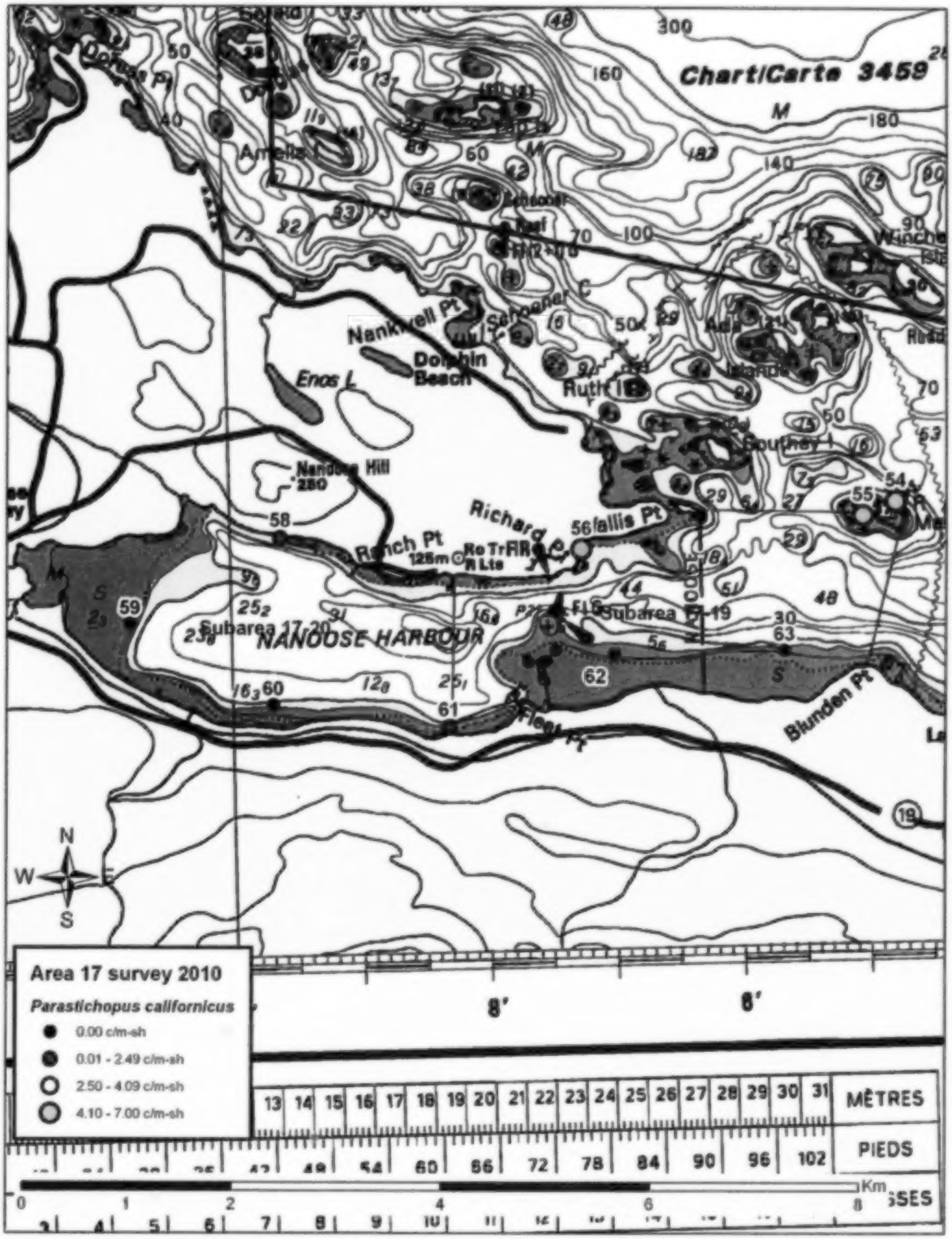

Chart/Carte 3459
Nankivell Pt
Dolphin Beach
Enos L
Nanoose Hill 280
Ruth I
Southey I
Richard Pt
Ranch Pt
Wallis Pt
Subarea 17-20
Subarea 17-19
NANOOSE HARBOUR
Blunden Pt
Fleet Pt
58
56
59
60
61
62
63
N
W
E
S
Area 17 survey 2010
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
● 4.10 - 7.00 c/m-sh
MÈTRES
PIEDS
Km
0
1
2
4
6
8

Figure 36. Linear density, number of sea cucumbers per metre of shoreline (c/m-sh), of *Parastichopus californicus* in PFMA Subareas 17–19 and 17–20, surveyed as part of the Area 17 survey in 2010. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and the baseline regional density for the East Coast Vancouver Island); and green = productive locations (between 4.10 c/m-sh and the maximum observed in the Subarea).